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Minerals Yearbook
1975

Volume I

METALS, MINERALS, AND FUELS

Prepared by staff of the

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • Cecil D. Andrus, Secretary

BUREAU OF MINES

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and park and recreation areas, and for the wise use of all those resources. The Department also has a major responsibility for American Indian reservation communities and for the people who live in Island Territories under U.S. administration.

U.S. GOVERNMENT PRINTING OFFICE

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Foreword

The Federal Government, through the Minerals Yearbook and its predecessor volumes, has reported annually on mineral industry activities for 94 years. This edition discusses the performance of the worldwide mineral industry during 1975. In addition to statistical data, the volumes provide background information to assist in interpreting the year's developments. Content of the individual volumes follows:

Volume I, Metals, Minerals, and Fuels, contains chapters on virtually all metallic, nonmetallic, and mineral fuel commodities important to the domestic economy. In addition, it includes a general review chapter on the mineral industries, a chapter on mining and quarrying trends, and a statistical summary.

Volume II, Area Reports: Domestic, contains chapters on the mineral industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, and the Commonwealth of Puerto Rico. This volume also has a statistical summary, identical to that in Volume I.

Volume III, Area Reports: International, contains the latest available mineral data on more than 130 foreign countries and discusses the importance of minerals to the economies of these nations. A separate chapter reviews the international minerals industry in general and its relationship to the world economy.

The Bureau of Mines continually strives to improve the value of its publications to its users. Therefore, the constructive comments and suggestions of readers of the Yearbook will be welcomed.

Director

Acknowledgments

Volume I, Metals, Minerals, and Fuels, of the Minerals Yearbook presents data on more than 90 mineral commodities that was obtained as a result of the mineral information gathering activities of the Associate Directorate —Mineral and Materials Supply/Demand Analysis.

The collection, compilation, and analysis of data on the domestic minerals and mineral fuel industries were performed by the staffs of the Divisions of Ferrous Metals, Nonferrous Metals, and Nonmetallic Minerals, Assistant Directorate—Metals, Minerals and Materials; the Divisions of Coal, Petroleum and Natural Gas, and Fuels Data, Assistant Directorate—Fuels; and the Division of Economic Analysis, Assistant Directorate—Interindustry and Economic Analysis. Statistical data were compiled from information supplied by mineral producers, processors, and users in response to production and consumption canvasses, and their voluntary response is gratefully appreciated. The information obtained from individual firms by means of confidential surveys has been grouped to provide statistical aggregates. Data on individual firms are presented only if available from published or other nonconfidential sources or when permission of the companies has been granted. Other material appearing in this volume was obtained from the trade and technical press, industry contacts, and numerous other sources.

Statistics on U.S. imports and exports, world production, and foreign country trade were compiled in the Office of Technical Data Services. U.S. foreign trade data were obtained from reports of the Bureau of the Census, U.S. Department of Commerce. World production and international trade data came from numerous sources, including reports from the Foreign Service, U.S. Department of State.

The Office of Technical Data Services also provided general guidance on the preparation and coordination of the chapters in this volume and reviewed the manuscripts to insure statistical consistency among the tables, figures, and text, between this volume and other volumes, and between this edition and those of former years.

Acknowledgment is also particularly made of the splendid cooperation of the business press, trade associations, scientific journals, international organizations, and other Federal agencies that supplied information.

The Bureau of Mines has been assisted in collecting mine production data and supporting information by numerous cooperating State agencies. These organizations are listed in the acknowledgments to Volume II.

ALBERT E. SCHRECK, *Editor-in-Chief*

Contents

Review of the Mineral Industries

By Daniel E. Sullivan,[1] Barry W. Klein,[1]
Mary Ann Good,[2] and Alan E. Knight [1]

The recession of 1974 continued into 1975. Real gross national product (GNP), measured in 1972 dollars, declined significantly in the first quarter of 1975 but rose slightly in the second and increased sharply in the third quarter. Unemployment peaked during the second quarter and then declined slowly for the balance of the year. The inflation rate declined owing to reduced demand and smaller-than-1974 increases in energy and food prices early in the year. Recovery was clearly evident by yearend, though unemployment and inflation remained at high levels.

Total output as measured by the GNP in current dollars rose 6.5% in 1975. Real GNP declined 2.0%, and inflation, as measured by the implicit price deflator, increased 8.7%. Real gross private domestic investment for residential structures declined 18.1% in 1975, which was a smaller rate of decrease than the 27% decline in 1974. Real State and local Government purchases increased 2.4%, and real personal consumption expenditures for services rose 1.7%. The Federal Reserve Board (FRB) index of industrial production declined 9.7%.

In 1975 the unemployment rate was 8.5%, which was the highest rate since 1941, up from 5.6% in 1974. The number of people employed declined during the year while the total labor force continued to increase. The unemployment rate reached a peak of 8.9% in May and then declined for the remainder of the year, except September-October, to 8.3% in December.

The Consumer Price Index (CPI) increased 9.1% in 1975, which was less than the 11.0% increase in 1974 but more than in any other previous year since 1947. Food prices rose 8.5% and all nonfood commodities increased 9.2%. The energy price component of the CPI rose 12% in 1975, which, although a high rate, was much less than the 29% advance in 1974. The 1975 increase resulted from the imposition of import fees on crude oil, a 60-cent import fee on refined petroleum products, and the passthrough of higher costs of energy materials by utilities. The wholesale price index increased 9.2% in 1975. Farm products and processed foods and feed increased 3.8%, (farm products alone declined 0.5%), and industrial commodities were 11.5% above their 1974 level. As previously mentioned, the 1975 implicit price deflator rose 8.7% from its 1974 level.

In response to the dilemma of recession and continued inflation in 1975, the FRB sought to ease monetary policy enough to support recovery yet not undermine the fight to lower inflation. The discount rate decreased from 7¾% at the beginning of 1975 to 6% by mid-May and remained at this level for the balance of the year. The money supply M_1, defined as currency plus demand deposits, grew 4.4% in 1975, down from 5% in 1974. M_2, defined as M_1 plus time and savings deposits, increased 8.2% in 1975 as compared with 7.7% in 1974.

Fiscal policy was expansionary in 1975. In late March, the Tax Reduction Act of 1975 was passed, which resulted in an $8 billion rebate of 1974 income taxes paid by individuals. This Act also cut corporate tax liabilities by a gross amount of $4¼ billion. Because of other corporate tax law changes, the net reduction was only $2½ billion. A Federal deficit was projected at $66.4 billion in 1975, but the

[1] Economist, Division of Economic Analysis.
[2] Statistical clerk, Division of Economic Analysis.

actual amount was $73.4 billion compared with $11.7 billion in 1974.

Total U.S. exports were $11.1 billion greater than imports in 1975, the largest surplus in the post-World War II period. For manufactured products, exports exceeded imports by $22.4 billion and for agricultural products by $12.4 billion. Imports of fuels, and minerals and metals were, respectively, $22.0 billion and $2.2 billion greater than exports.

The Federal Government continued some activities and initiated others in 1975 that affected the minerals sector. The Government continued efforts to reduce inflation. Mineral-related legislation enacted in 1975 was in areas such as energy, taxation, the environment, water, public lands, transportation, and duties. Energy legislation included the elimination of the percentage depletion allowance for oil and natural gas integrated producers; tax legislation affecting fuels; and several measures to improve the U.S. energy position.

Bureau of Mines research programs are designed to foster efficient utilization of our mineral resources, and insure adequate mineral supplies without objectionable environmental, social, and economic effects. During 1975, the Bureau's scientific and technical investigations continued in pursuit of improved mineral technology.

Total energy use in the United States decreased 2.5% in 1975, which was the first 2-year decline since 1945-46. Reasons for this downturn included lowered economic activity, higher fuel prices, a relatively mild winter, and energy conservation efforts. Consumption declined for all energy sources except nuclear power and bituminous coal and lignite. The largest decrease of all major consuming sectors was in industrial energy use. Petroleum (including natural gas liquids) remained as the Nation's largest energy source, supplying 46% of the 1975 total. Despite work stoppages and continuing productivity declines, production of bituminous coal and lignite continued to increase.

In 1975, the mining industry faced environmental problems, uncertainties, and, in general, higher mining costs. Plans for developing new mining operations and expanding existing ones were, in many cases, canceled or delayed. Production in the ferrous and nonferrous metals sectors declined in response to reduced demand. The shortages of materials, supplies, equipment, and manpower, present in 1974, ameliorated in 1975.

The world economy turned upward in 1975, overcoming the most serious recession since the Great Depression. Inflation rates moderated relative to the 1972–74 period but remained at high levels by historical standards. The fourfold increase in world oil prices that occurred in 1974 continued to cause some major economic dislocations in the developed oil consuming nations in 1975, but the less developed oil importing countries faced the most severe balance of payment problems. Capital investment, which could be used to increase world production of goods and services, has instead been diverted to replace equipment made obsolete by high, rapidly rising energy prices.

SOURCES AND USES

ALL MINERALS

Production.—In 1975 domestic raw mineral production was valued at $62.3 billion, a 13% increase over the 1974 figure. Production of mineral fuels increased 16%, nonmetals rose 10%, and metals declined more than 6%. In constant 1967 dollars the total raw mineral output value declined over 5% from $26.1 billion in 1974 to $24.6 billion in 1975; metals and nonmetals declined 11% and 12%, respectively, and mineral fuels declined 2%. Total mineral raw material exports rose 32% to $4.7 billion, and imports increased 17% to $22.7 billion.

The decline in physical output of minerals as part of the general economic recession is reflected in the Bureau of Mines indexes of the physical volume of mineral production (1967=100). With the exception of coal, all of the indexes showed declines. The overall index declined about 6% to 103.9 index points. The metal index declined almost 10%; the nonmetal index, almost 12%; and the fuel index, 3%. The ferrous and nonferrous metal indexes declined about 11% and 9%, respectively. The base metal index, which with the monetary index and the other nonferrous metal index make up the nonferrous metal index, also declined about 10%. The monetary metal and other nonferrous metal indexes declined less than 1% and 3%, respectively. The construction and other nonmetal indexes declined almost 14% and 15%, respectively. The chemical index declined less than 5%. As mentioned previously, the coal index increased. However, its almost 7% increase was not enough to offset the over 5% decline in the more heavily weighted crude oil and natural gas index, which caused the overall fuel index to decline.

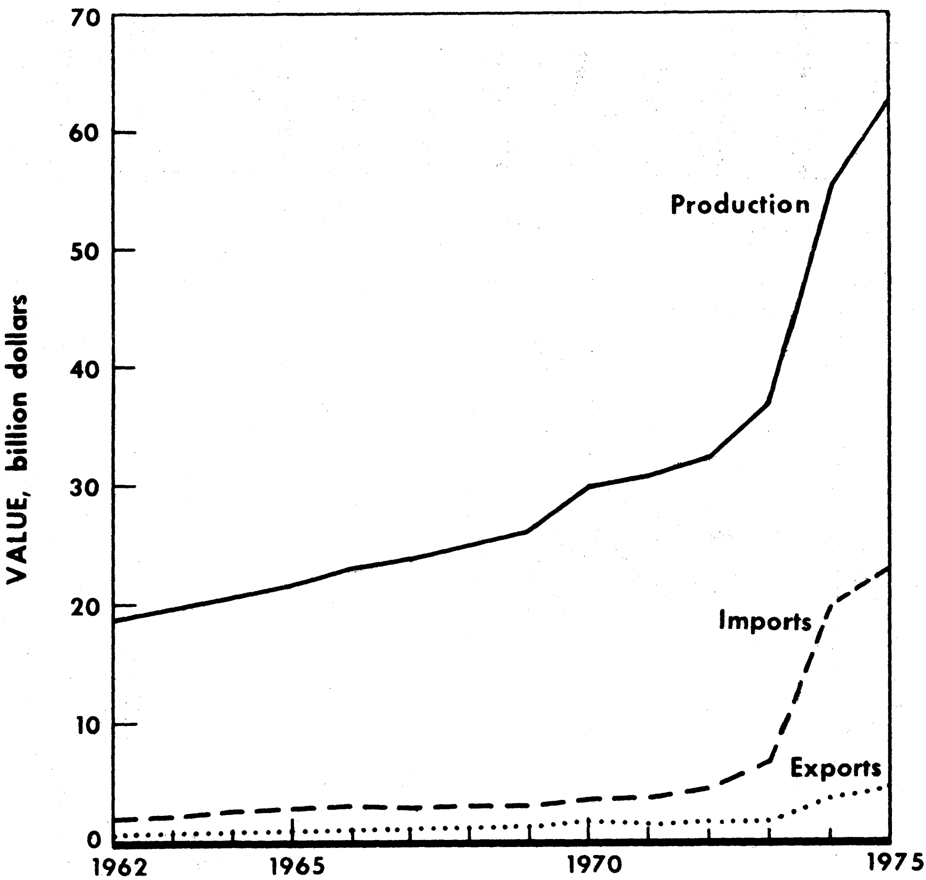

Figure 1.—Value of raw mineral production, exports, and imports.

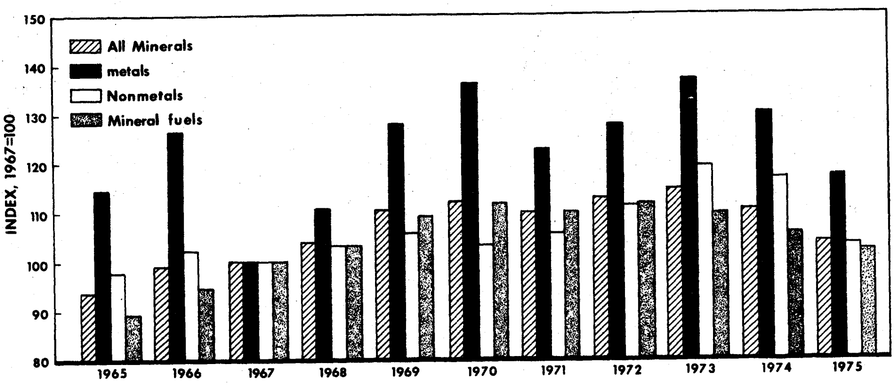

Figure 2.—Indexes of physical volume of mineral production in the United States, by group.

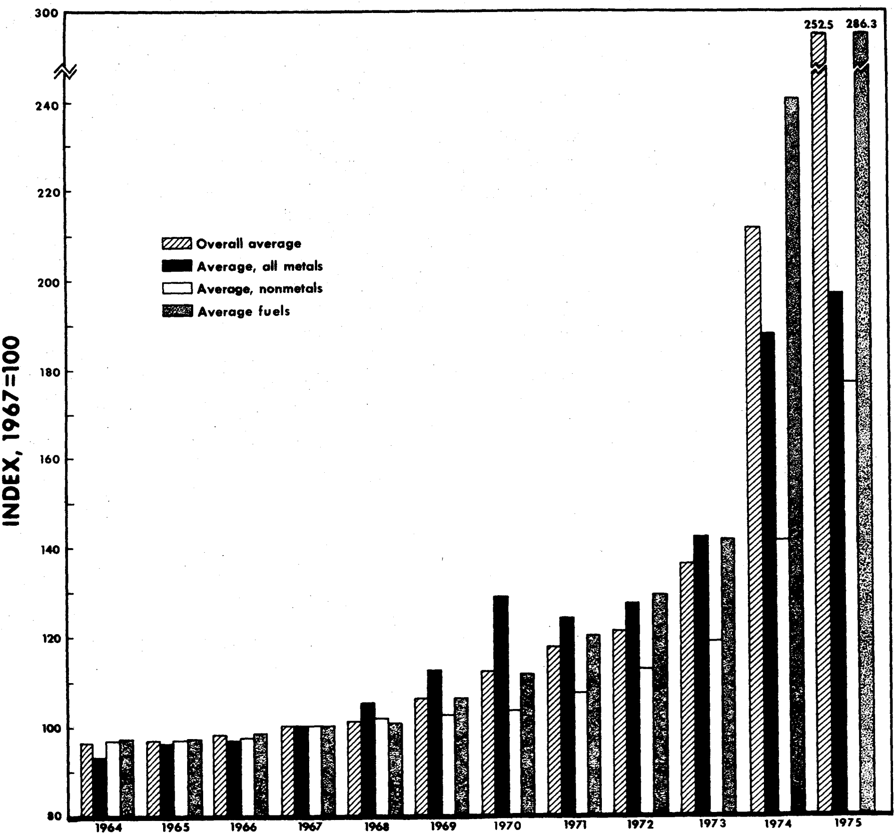

Figure 3.—Indexes of implicit unit value.

The FRB index of industrial production (1967=100) for all industries declined almost 9% to 113.7 index points in 1975. The average for all mining declined more than 2% to 106.6 index points. The average index for the production of metal, stone, and earth minerals declined over 6% to 109.8 index points. The metal index declined just less than 6% to 121.7 index points, and the stone and earth minerals index declined less than 7% to 101.7 index points. The average index for the production of coal, oil, and gas declined over 1% to 105.8 index points. The production index for coal increased more than 8% to 113.8 index points, but the average index for crude oil and natural gas declined almost 3% to 104.5 index points.

The production index for primary metals declined almost 22% to 97.0 index points. The iron and steel production index declined 20% to 95.9 index points, and the nonferrous metals and products index declined over 24% to 99.3 index points. The clay, glass, and stone products index declined over 13% to 108.8 index points.

The FRB average production index for all mining by month was 107 index points in January. It increased to near 109 index points in February and remained near 109 the next 2 months. It declined to near 106 index points in May, where it remained for the next 2 months. It declined to 105 index points in August then gradually increased until it reached almost 107 points in November. In December it declined to near 105 index points. The monthly index of production for coal, oil, and gas followed a similar pattern. It was near 104 index points in January, increased to near 108 in March, and declined to less than 106 in May. In June it was again close to 108, declined to near 104 in August, and increased to near 106 in October where it remained until December when it was below 105 index points. The individual coal index and oil and gas extraction indexes also followed similar patterns. The metal, stone, and earth minerals index was near 119 in January, dropped almost to 113 in March, to near 106 in May, and to slightly above 101 in June. In July it rose to 105 and for the next 2 months remained near 107. It increased to 110 in November and declined to near 108 in December. The individual indexes of metal mining and stone and earth mineral mining generally followed similar patterns through the year.

The net supply for most principal metals and nonmetals declined during 1975. The net supply for all but two ferrous metals declined: Iron ore, pig iron, and steel ingot decreased by more than 8%, 17%, and 19%, respectively; cobalt declined 48%; tungsten, 40%; chromite, 9%; and nickel, 5%. Manganese increased by almost 52% and molybdenum almost 14%. The net supply of all nonferrous metals except tin declined. Platinum-group metals and cadmium had the largest decline at 42% and 40%, respectively. Aluminum, zinc, and antimony showed decreases in the range of 20% to 22%; copper, 9%; and uranium concentrate, 7%. Lead, mercury, and ilmenite and slag showed declines from 1% to 6%. Tin increased by 12%. The net supply of all but two nonmetals declined or showed no change. Talc and allied minerals experienced the greatest decline at 27%, followed by asbestos at 26%, finished fluorspar at 22%, and clays at 20%. Crushed stone, sand and gravel, gypsum, common salt, and potash all declined by percentages in the teens. Bromine decreased 6%; sulfur, 2%; and mica showed no change. The net supply of phosphate rock rose almost 14% and that of crude barite increased 5%.

Stocks and Government Stockpiles.—Stocks of crude nonfuel minerals at primary producers, as illustrated by the Bureau of Mines index (1967=100), rose for all but one category in 1975. The overall index increased 27% and the metals index increased 16%. Within the metals sector, the iron ore index increased 23%, the nonferrous index increased 2%, and the other ferrous index declined 20%. The largest gain in the crude mineral category was for nonmetals, which rose almost 37%. The Bureau of Mines index of stocks of nonfuel minerals at manufacturers, consumers, and dealers (1967=100) also increased in all but one category, though the overall increase, at 13%, was considerably smaller than that for crude minerals. The metals sector index increased almost 14% and all metal subgroups showed increases. Other ferrous increased over 29%, followed by iron at under 18%, base nonferrous at less than 17%, and other nonferrous at almost 1%. Unlike producer stocks where nonmetals showed the largest increase of all groups and subgroups, the nonmetals declined 9% for mineral manufacturing consumers and dealers.

Producer stocks of bituminous coal and lignite increased by one-third during 1975. Those of coke increased fivefold, reflecting lower consumption by the steel industry. Stocks of most petroleum and related products also increased with three exceptions: Carbon black, which declined over 21%; natural gasoline, plant condensates, and isopentane, which declined over 2%; and special naphthas, which declined over 23%. Stocks of crude petroleum and petroleum products increased almost 6%. Stocks of all of its constituents, except special naphthas as mentioned previously, also increased. Crude petroleum stocks increased over 2%; gasoline, almost 8%; liquefied gases, almost 8%; distillate fuel oil, over 4%; residual fuel oil, over 24%; petroleum asphalt, almost 7%; and the other products category, nearly 3%. Stocks of natural gas increased almost 8%.

The seasonally adjusted book value of product inventories increased for all but one of the selected mineral processing industries during 1975. Petroleum and coal products increased almost 10% to $4,313 million, as of December 1975. Stone, clay, and glass products declined over 2% to $3,630 million after having increased over 32% during 1974. Total primary metals inventories increased over 17% to $13,924 million. Blast furnace and steel mill inventories increased almost 33% to $7,627 million, and other primary metals inventories increased 3% to $6,297 million. The total seasonally adjusted book value of inventories for selected mineral processing industries increased over 12% to $21,867 million during 1975.

Of continuing importance to the mineral industry were U.S. Government inventories of basic stockpile materials. Materials on hand as of December 31, 1975, with high market values included bauxite, chromium, diamond, lead, manganese, silver, tin, tungsten, and zinc.

Exports.—The total value of selected minerals and mineral products exported during 1975 increased almost 10%. Only the two metal sectors did not increase. Exports of crude and scrap metals declined a little more than 8% and those of manufactured metals declined over 7%. Crude nonmetallic mineral exports increased over one-third. Exports of mineral energy resources and related products increased over 30%; those of chemicals, over 16%; and those of manufactured nonmetallic minerals, almost 10%.

The general pattern of the geographic distribution of exports of selected mineral commodities remained generally stable in 1975. For some commodities the export distribution pattern did change. For example, in the case of iron and steel ingots and other primary forms, the share of exports to North America increased 27 percentage points to 62%, that of South America decreased 20 percentage points to 15%, and that of noncentrally planned Asia declined 11 percentage points to 4%. In the case of silver, platinum, and platinum-group metals, the share of exports to North America were 22 percentage points less and to noncentrally planned Asia were 12 percentage points less than in 1974, and the percentage exported to noncentrally planned Europe was double what it had been in 1974. The share of zinc and zinc alloy exports that went to South America declined from one-third to one-fifth, that to noncentrally planned Asia declined from 19% to 6%, and that to noncentrally planned Europe increased from 30% to 52%. The change in the pattern of tin and tin alloys exports was an upward shift in the shares to North America and South America of 35 percentage points to 55% and 18 points to 24%, respectively, and a shift downward for noncentrally planned Europe of 54 points to 17%. The distribution of exports of uranium and thorium and their alloys shifted away from North America, down 15 percentage points, to 26%; away from noncentrally planned Europe, down 20 percentage points, to 28%; toward noncentrally planned Asia, up 26 points to 34%; and to Oceania, up from zero to 12%.

Imports.—The total value of selected minerals and mineral products imported during 1975 decreased almost 2% from the high 1974 levels. This was caused by declines in imports in the manufactured nonmetallic minerals sector of 16% and the manufactured metals sector of 22%. In all other sectors the value of imports increased. The value of crude nonmetallic minerals imported increased just over 1%; those of crude and scrap metals, almost

7%; those of mineral energy resources and related products, over 4%; and chemicals, over 19%.

The general geographic distribution pattern for imports of selected mineral commodities remained generally stable during 1975. However, as was the case for exports, the pattern did change for some commodities. Imports of phosphates, crude and apatite, were all from North America, while in 1974 noncentrally planned Asia and Africa supplied 10% and 16%, respectively. The percentage of mica, including scrap, imports from North America and noncentrally planned Asia increased and that from South America declined. The share of copper ores and concentrates from North America increased, and those from South America and noncentrally planned Asia declined. The shares of tin waste and scrap from North America and noncentrally planned Asia declined 64 percentage points to 8% and 21 percentage points to 1%, respectively; that from noncentrally planned Europe increased 85 percentage points to 91%. The shares of platinum-group metal ores, concentrates and waste imports from North America and South America increased, and those from noncentrally planned Europe and Asia declined.

Consumption.—In 1975 consumption of most major mineral products dropped significantly. All selected ferrous metals showed declines. Raw steel consumption declined almost 20%, and iron ore consumption decreased over 17%. Metallurgical-, refractory-, and chemical-grade chromite ores decreased at rates of 41%, 38%, and 34%, respectively, the largest declines of all ferrous metals. Molybdenum consumption fell almost 19%; tungsten, 14%; and manganese ore, 3%. Consumption of all major nonferrous metals declined with the exception of estimated private purchases of uranium, which increased 5%. Refined copper consumption declined 30%; primary antimony, 28%; all classes of zinc, more than 26%; and platinum, almost 34%. Apparent consumption of aluminum, primary and secondary lead, and ilmenite and titanium slag declined at rates between 19% and 21%. Primary mercury decreased 15%, and industrial consumption of silver declined 10%. Consumption of all selected major nonmetals declined. Phosphate rock showed the largest decline at 31%, followed by asbestos at 28%, and sand and gravel and clays both at 19%. Potash, crushed stone, cement, and salt decreased at rates between 13% and 17%. Lime consumption declined over 11% and sulfur fell 2%.

Total energy resource inputs in terms of British thermal units (Btu) declined almost 3%. Bituminous coal consumption increased, anthracite remained unchanged, and natural gas and petroleum including natural gas liquids fell. Total net electricity generation increased. In the utilities sector, electricity generation at conventional fuel-burning plants and at hydropower plants declined, while that at nuclear power plants increased by half. Industrial electricity production declined.

ENERGY

Energy use in the United States decreased in 1975 for the second year in a row. The 2.5% decline from 1974 was largely attributable to the 6% decrease in energy use by the industrial sector that, in turn, was caused by lowered economic activity, higher fuel prices, and greater energy conservation. Net imports of all fuels fell 4.4% on a Btu basis from 1974 levels, accounting for 16.1% of 1975 total gross energy use—about the same as in 1974. Consumption on a Btu basis declined for all energy sources with the exception of nuclear power. There was a 2% decrease in per capita energy use and the ratio of energy use to GNP declined slightly in 1975. This ratio of energy use to GNP has declined since 1971, indicating the U.S. economy is using energy more efficiently to create GNP.

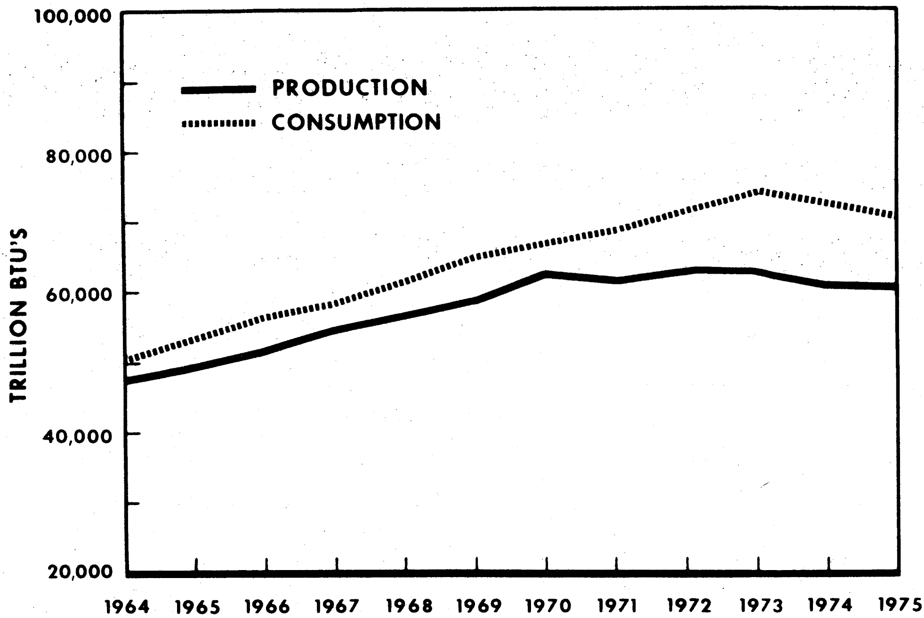

Figure 4.—Production and calculated gross consumption of mineral energy resources and electricity from hydropower and nuclear power.

Production.—Total production of mineral energy resources and electricity from hydropower and nuclear power in 1975 declined almost 2% to 60,135 trillion Btu. All sources of energy production declined except bituminous coal and lignite, which increased 6% but accounted for 25% of total production, and nuclear power, which increased 51% but accounted for only 3% of total production. Anthracite declined 6%; natural gas, 7%; petroleum, almost 5%; and hydropower, a negligible amount.

Consumption.—In 1975 U.S. energy consumption declined almost 3% to 70,558 trillion Btu. Consumption of all energy resources declined except for electricity from nuclear power, which increased 51%. Anthracite consumption fell almost 6% in terms of Btu's; bituminous coal, less than 1%; and coke, over 76%. Petroleum consumption dropped 2%; natural gas, more than 8%; and natural gas liquids, almost 4%. Consumption of electricity from hydropower declined more than 2%.

In 1975 the household and commercial sector received 43% of its energy input from natural gas, 33% from petroleum, 23% from electric utilities, and the remaining 1% from coal. For industrial users, the corresponding shares were approximately 42%, 27%, 13%, and 18%. Petroleum accounted for almost 97% of transportation's energy consumption. Energy input to electric utilities was 43% from bituminous coal and lignite, 16% each from petroleum, natural gas, and hydropower, and 9% from nuclear power.

Coal.—In 1975 the domestic supply of anthracite declined more than 6% to 5.1 million tons; that of bituminous coal and lignite increased less than 1% to 556 million tons. Exports of anthracite declined almost 7% and those of bituminous coal rose almost 10%; bituminous coal imports decreased 55%. The household and commercial sector accounted for about 44% of anthracite consumption, and the remainder was almost equally divided between electric utility power generation and industrial uses. Electric utilities accounted for 73% of bituminous coal consumption, and industrial uses, for another 26%.

Natural Gas.—The domestic supply of natural gas declined 8% in 1975 to 19,538 billion cubic feet. Domestic production continued to decline, dropping to 19,236 billion cubic feet or 7% below the 1974 level. Exports declined over 5% and imports decreased less than 1%. Net stock additions rose more than 300%. Demand for natural gas declined 15% in the industrial sector, rose 1% in the household and commercial sector, and declined in the other consuming sectors.

Petroleum.—The domestic supply of crude oil in 1975 increased almost 3% to 4,541 million barrels. Domestic production continued to decline, falling to 3,057 million barrels, which represented a decrease of almost 5% from the 1974 figure. An 18% increase in imports contributed to the larger 1975 supply. Exports and stocks remained negligible. The domestic supply of refined petroleum products declined 2% to 5,954 million barrels. The demand for petroleum declined in all consuming sectors except transportation, which increased 1% and accounted for over 62% of all petroleum consumed.

Nuclear Energy.—In 1975 nuclear energy consumption was 51.4% greater than that of 1974. In terms of Btu's it rose from 1.7% of total energy consumption in 1974 to 2.6% of the total in 1975.

Hydropower.—Consumption of hydropower in 1975 declined 2.4% from the 1974 figure. Hydropower accounted for 4.6% of U.S. total energy consumption in 1975, the same as that of 1974.

Other Energy.—The search for alternate energy sources continued during 1975. Under development were geothermal, oil shale, solar, wind, nuclear fusion, tidal, and biological (from organic wastes) sources. World output of geothermal energy was double what it had been in 1972. The United States was the largest producer of geothermal power, all of which was produced at one site. Because of economic, technical, geologic, and environmental factors, additional development of geothermal power on federally leased lands in 1975 was minimal. Oil shale development proceeded, in spite of problems involving high costs and environmental concerns. The other alternate sources of energy remained minor or theoretical, but there was strong interest in the development and expansion of solar, wind, and fusion power into significant energy sources.

EMPLOYMENT AND PRODUCTIVITY

Employment.—Employment in selected mineral industries changed in a mixed pattern during 1975. Total mining employment increased almost 11% to 744,900. Metal mining employment was unchanged at 92,300, although employment in iron mining increased over 2% and employment in copper mining declined over 13%. Nonmetal mining and quarrying employment declined over 3% to 115,100. Total employment in the fuel industries increased almost 17% to 537,500. Employment in coal mining increased about 20%, employment in crude petroleum and natural gas fields increased 11%, and employment in oil and gasfield services increased almost 19%.

Total mineral manufacturing employment declined almost 8% to 888,400 during 1975. Nonfuel mineral manufacturing employment declined 10% to 691,000. Employment at fertilizer plants (complete and mixing), blast furnaces, steelworks and rolling mills, and nonferrous smelting and refining plants all declined about 10%; employment in the hydraulic cement industry declined over 7%.

Hours and Earnings.—Average hourly earnings in the extractive industries increased more than 10% to $5.42 for nonfuels, and almost 14% to $6.14 for fuels. Hours worked declined more than 2% in the nonfuels industry, but increased almost 1% in the fuels industry. The resulting increases in weekly earnings were more than 7% for nonfuels and almost 15% for fuels. Within the nonfuels industry, average hourly earnings increased about 13% to $6.13 for metal mining and more than 7% to $4.85 for nonmetallic mining and quarrying. As weekly hours declined over 2% in metal mining, weekly earnings only increased about 10%. In the nonmetallic mining and quarrying industry, weekly hours declined 6% causing weekly earnings to increase less than 1%. Within the metal mining sector, iron ores showed average hourly earnings increasing more than 14% to $6.34, average weekly hours declining almost 2%, and average weekly earnings increasing more than 12%. Copper ores showed average hourly earnings increasing almost 15% to $6.33, average weekly hours decreasing almost 5%, and average weekly earnings increasing almost 10%. Within the extractive fuels industries, average hourly earnings in coal mining increased more than 16% to $7.21, average weekly hours increased nearly 3%, and average weekly earnings increased almost 20%. Average hourly earnings in the crude petroleum and natural gas industries increased over 13% to $6.05, average weekly hours declined nearly 3%, and average weekly earnings increased over 11%.

For all manufacturing, hourly earnings increased over 11% to $6.71 during 1975, weekly hours declined almost 4%, and weekly earnings increased 7%. Weekly hours declined for all of the selected mineral manufacturing industries. Hourly earnings for the fertilizer industry (complete and mixing) increased almost 11% to $4.43, weekly hours declined over 1%, and weekly earnings increased less than 10%. For the hydraulic cement industry, hourly earnings increased over 7% to $6.33, weekly hours declined almost 2%, and weekly earnings increased less than 6%. Hourly earnings in the blast furnaces, steel and rolling mills industry increased more than 11% to $7.11, weekly hours declined just over 5%, and weekly earnings declined almost 6%. Hourly earnings in the nonferrous smelting and refining industry increased almost 11% to $5.96, weekly hours declined over 3%, and weekly earnings increased over 7%. In petroleum refining and related industries hourly earnings increased 14% to $6.42, weekly hours declined nearly 2%, and weekly earnings increased nearly 12%. In petroleum refining, hourly earnings increased almost 16% to $6.89, weekly hours declined just over 2%, and average weekly earnings increased just over 13%. Hourly earnings for other petroleum and coal products increased almost 10% to $5.03, weekly hours declined almost 2%, and weekly earnings declined just under 8%.

Wages and Salaries.—During 1975 total wages and salaries for all industries increased over 5% to $806.7 billion. In the mining sector the increase was over 21% to $10.7 billion, and in the manufacturing sector total wages increased only slightly to $211.7 billion. The 1974 figures, which were not available last year, show total wages and salaries for all industries increasing 9% to $764.5 billion; those in the mining sector, increasing over 21% to $8.8 billion; and those in the manufacturing sector, increasing almost 8% to $211.4 billion. During 1975 the average earnings of full-time employees in all industries increased almost 9% to $10,892; in the mining sector, the increase was almost 14% to $14,647; and in the manufacturing sector, the increase was about 10% to $11,941. These figures also were not available in 1974. During 1974 average earnings of full-time employees in all industries increased almost 8% to $10,004; in the mining sector, the increase was over 10% to $12,896; and in the manufacturing sector, the increase was over 8% to $10,845.

Labor Turnover Rates.—The total accession rate (hires and rehires) for the manufacturing sector declined almost 12% during 1975. Six of the nine selected mineral industries also showed declines in their accession rates. The accession rate for hydraulic cement increased over 93%, the rate for blast furnaces, steel and rolling mills increased 40%, and the rate for coal mining increased over 21%. Those showing declines in accession rates were iron ores, over 11%; petroleum refining and related industries, almost 22%; metal mining, almost 23%; petroleum refining, over 29%; nonferrous smelting and refining, over 33%; and copper ores, almost 41%.

The total separation rate for the manufacturing sector declined more than 12% during 1975. Six of the nine selected mineral industries showed increases in their separation rates. They were hydraulic cement, over 86%; blast furnaces, steel and rolling mills, almost 83%; iron ores, almost 29%; nonferrous smelting and refining, over 15%; coal mining, almost 8%; and metal mining, over 3%. The separation rate for copper ores remained unchanged. The rate for petroleum refining declined 20%, and that for petroleum refining and related industries declined almost 21%.

The layoff rate for the manufacturing sector increased 40%. The layoff rate increased substantially for all of the six selected nonfuel mineral industries. It more than quadrupled for the blast furnaces, steel and rolling mills industry, the nonferrous smelting and refining industry, and the copper ore industry; the layoff rate more than tripled for the hydraulic cement industry, the metal mining industry, and the iron ore industry. The layoff rate remained unchanged in petroleum refining and related industries and the coal mining industry, and it declined 25% in the petroleum refining industry.

Productivity.—The indexes of labor productivity for selected mineral industries during 1974 (latest data available) all declined. The index of crude copper ore mined per employee declined over 7%, per production worker the index declined over 6%, and per production worker man-hour it declined over 3%. The same indexes for recoverable copper metal declined over 12%, almost 11%, and over 8%, respectively. The indexes of crude iron ore mined per employee and per production worker each declined over 5%, and the per production worker man-hour index declined almost 7%. For usable iron ore mined, the first two indexes declined almost 9% and the last index, almost 10%. The indexes for refined petroleum per employee, per production worker, and per production worker man-hour declined about 5%, 6%, and almost 7%, respectively. Those for bituminous coal and lignite declined about 7%, 6%, and 2%, respectively.

PRICES AND COSTS

Index of Average Unit Mine Value.—The index of average unit mine value (1967=100) is designed to reflect the unit values of mine production. It shows the unit mine values of most minerals increasing during 1975; only the base and monetary nonferrous metals indexes declined. The total index of average unit mine value increased almost 18% to 252.9 index points. The metal index increased 12%; the nonmetal index, over 23%; and the fuel index, over 17%. The ferrous metal index increased 30%. The nonferrous metal index declined just over 3%, reflecting an almost 12% decline in the base nonferrous metal index and an almost 10% decline in the monetary metal index. The other nonferrous metals index increased over 42%. In the nonmetallic mineral sector, the construction index increased about 16%, the chemical index increased over 52%, and the other nonmetals index increased almost 16%. In the fuels sector, both the coal index and the crude oil and natural gas index increased over 19%.

Index of Implicit Unit Value.—The index of implicit unit value (1967=100) is designed to reflect the unit values of the minerals included in the index of the physical volume of mineral production. For 1975 it reflects the same pattern of price changes as the aforementioned index of average unit mine value. With the exception of base and monetary nonferrous metals the indexes all increased. The total index of implicit unit value increased over 19% to 252.5 index points. The metal index increased almost 5%; the nonmetal index, about 25%; and the fuel index, about 19%. The ferrous metal index increased almost 30%. The nonferrous metal index declined over 6%, reflecting an almost 13% decline in the base nonferrous metal index and an over 3% decline in the monetary metal index. The other nonferrous metals index increased over 45%. In the nonmetallic mineral sector, the construction index increased 16%, the chemical index increased 57%, and the other nonmetals index increased almost 17%. In the fuels sector, the coal index increased just over 19% and the crude oil and natural gas index increased over 20%.

Prices.—In 1975 wholesale price indexes for selected metals, minerals, and fuels increased at significantly lower rates than those in 1974. The index for all commodities increased over 9%, less than half the 1974 rate; for commodities other than farm and food it increased 11.5%, also nearly half the 1974 rate. The index for metals and metal products increased 8%, nearly a quarter of the 1974 rate. Not only were the rates of increase lower than those in 1974, but several indexes in the metals and metal products categories actually decreased. Iron and steel scrap decreased 30%, to 254.6; nonferrous scrap decreased 35%, to 128.3; nonferrous metals decreased over 8%, to 171.6; and common pig lead decreased over 3%, to 154.0. Metals and metal products increasing significantly were the following: Iron ore, 25%; semifinished steel products, over 22%; finished steel products, over 15%; foundry and forge shop products, 20%; pig iron and ferroalloys, nearly 41%; and primary metal refinery shapes, about 63%.

The overall index for nonmetallic mineral products increased about 13% to 174.0, with many of the indexes for nonmetallic mineral products increasing at about the same rate. Exceptions included the following: Gypsum products, which increased the least, less than 5%; phosphate rock increased the most, 133%; phosphates, nearly 100%; nitrogenates, 40%; fertilizer materials, over 60%; and potash and insulation materials, over 25%. The price index for fuels and related products and power increased about 18%; price indexes for most selected fuels increased at about this rate. Exceptions included the following: Anthracite, which increased over 50%, and coke and gas fuels, which both increased by about one-third.

Prices of mineral energy resources continued to increase in 1975 with the exceptions of Bunker C residual fuel oil at all gulf ports and No. 2 distillate, which decreased from $10.28 to $9.30 per barrel, and from 30.69 cents to 28.43 cents per gallon, respectively. The average price of bituminous coal at merchant coke ovens increased at the largest rate, nearly 54% to $52.63 per short ton; average sales realization prices for anthracite increased between 35% and 43% to between $38.40 and $42.15 per ton. Average prices of residual fuel oil, after doubling in 1974, remained fairly stable; No. 6 fuel, maximum 1% sulfur, was $12.26 per barrel, up from $11.95; No. 6 fuel, maximum 0.3%, at Philadelphia, was $13.16 per barrel, up only $.05 from 1974. The average price of No. 2 distillate fuel oil at Philadelphia increased over 16% to 29.19 cents per gallon. The average value at the well for natural gas increased over 43% to 43.5 cents per thousand cubic feet, and at the point of consumption almost 30% to $1.15 per thousand cubic feet.

During 1974 (latest data available) the average cost of electricity increased sharply owing to the higher price of imported oil. Of all the regions, New England price increases were the greatest, reflecting the dependence on imported oil. The cost of residential electricity increased over 35%, raising the average price to 4.2 cents per kilowatt-hour. Commercial and industrial electricity prices increased over 43% to 3.3 cents per kilowatt-hour. The Middle Atlantic region experienced similar price increases as did Alaska and Hawaii. In the East South-Central region the cost of electricity was the lowest, partly due to the influence of the Tennessee Valley Authority (TVA). The nationwide average cost of electricity increased 0.4 cents per kilowatt-hour for residential as well as commercial and industrial electricity, raising prices to 2.8 cents per kilowatt-hour and 2.0 cents per kilowatt-hour, respectively.

Principal Metal Mining Expenses.—The index of principal metal mining expenses (1967=100) increased 14% to 196 index points. The labor component increased at about the same rate to 205 index points, and the supply component increased less than 13% to 177 index points. The fuel component increased almost 18% to 245 index points, and the electrical energy component increased more than 18% to 193 index points.

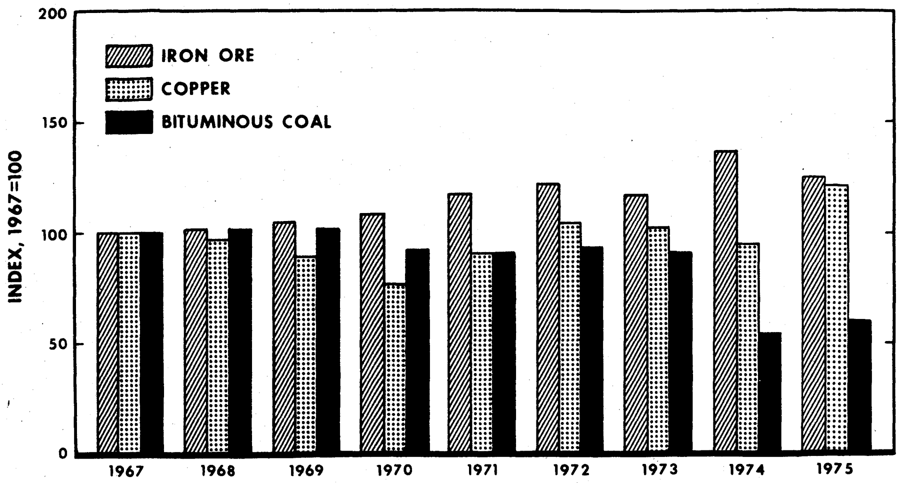

Figure 5.—Index of labor costs per dollar of product.

Costs.—The 1975 indexes of relative costs and productivity (1967=100) in general showed increases in labor costs per unit of output and mixed changes in both the value of product per man-period and labor costs per dollar of product. For iron ore, the index of labor costs per unit of output and the index of value of product per man-period both increased strongly but the index of labor costs per dollar of product declined. For copper, the index of labor costs per unit of output increased and the index of value of product per man-period declined. The index of labor costs per dollar of product increased significantly. For bituminous coal, the index of labor costs per unit of output increased significantly, and the index of value of product per man-period increased moderately. The index of labor costs per dollar of product increased slightly. The petroleum indexes of labor costs per unit of output rose 22% in 1974 (latest data available), the value of product per man-period increased by 58%, and the index of labor costs per dollar of product declined almost 30%.

The 1975 price indexes for mining construction and material handling machinery and equipment (1967=100) all increased significantly. The index for portable air compressors and the index for mixers, pavers, spreaders, etc., both increased about 13%. The indexes for construction machinery and equipment; power cranes, excavators, and equipment; scrapers and graders; and tractors other than farm each increased by more than one-fifth. The indexes for oilfield machinery and tools and specialized construction machinery both increased about one-fourth. Mining machinery and equipment again increased the most, at 28%.

INCOME AND INVESTMENT

National Income Generated.—National income originating in all industries was $1,236 billion in 1975, a more than 7% increase above that of 1974. National income originating in the mining sector increased more than 22% to $18.8 billion. The largest share of income originating in the mining sector was from the crude petroleum and natural gas industry. It was $8.2 billion, almost 24% greater than that of 1974. Income originating in the coal mining sector, $6.7 billion, was almost 30% greater than that of 1974. Income from the mining and quarrying of nonmetallic minerals increased over 2% to $2.1 billion, and income in the metal mining sector increased 10% to $1.7 billion. Income originating in the manufacturing sector increased 4% to $309.9 billion. Income originating in the primary metal industries declined almost 7% to $26.0 billion; in the chemicals and allied products industries it increased nearly 10% to $23.8 billion; in the petroleum refining and related industries it declined 2% to $13.8 billion; and in the stone, clay, and glass products industry it declined over 2% to $9.5 billion. Information relating to national income originating in the mineral industries was not available last year. During 1974 national income originating in all industries increased over 7% to $1,152 billion. In mining it increased almost 52% to $15.4 billion. Within this sector, income originating in the petroleum and natural gas industry increased about 69% to $6.6 billion; in coal mining it increased about 81% to $5.2 billion; in the nonmetallic sector it increased over 10% to $2.1 billion; and in metal mining it increased over 3% to $1.5 billion. Income originating in the manufacturing sector increased over 5% during 1974 to $298.2 billion. Income originating in the primary metal industries increased almost 28% to $28.0 billion; in the chemicals and allied products industry it increased over 6% to $21.7 billion; in the petroleum refining and related products industry it increased almost 65% to $14.1 billion; and in the stone, clay, and glass products industry it declined almost 1% to $9.7 billion.

Profits and Dividends.—The average annual profit rate on shareholders' equity in all manufacturing industries decreased more than 3 percentage points during 1975 to 11.6%. All of the selected mineral manufacturing industries showed substantial decreases in profit rate. The profit rate for primary metals decreased almost 8 percentage points to 8.5%; that for primary iron and steel decreased over 6 percentage points to 10.7%; that for primary nonferrous metals declined over 10 percentage points to 5.2%; that for stone, clay, and glass products declined almost 4 percentage points to 6.8%; for chemicals and allied products it declined over 3 percentage points to 15.2%; and for petroleum and coal products it declined over 8 percentage points to 12.5%.

Total dividends for all manufacturing increased almost 3% to $19,995 million during 1975. Total dividends declined for all of the selected mineral manufacturing industries except petroleum and coal products, which increased over 5% to $4,266 million. Total dividends for primary metals declined almost 4% to $1,172 million; for primary iron and steel the decline was over 2% to $717 million; for primary nonferrous metals the decline was 6% to $454 million; for stone, clay, and glass products the decline was almost 2% to $442 million; and for chemicals and allied products the decline was over 1% to $2,758 million.

The total number of industrial and commercial failures and their current liabilities were up significantly in 1975 over what they had been in 1974. The number of failures increased over 15% to 11,432 and their current liabilities were $4.4 billion, which is over 43% greater than the equivalent figure for 1974. The number of failures in the mining sector almost tripled to 26 from the 9 of 1974, although it was not as great as the 32 of 1973. The current liabilities of mining failures at $9.5 million were more than 6% less than those of 1974. In the manufacturing sector the number of failures and their liabilities were both greater than their 1974 equivalents but not by as great a magnitude as the 15% and 43% increases in the total number of failures and their liabilities shown in the preceding text.

New Plant and Equipment.—Expenditures for new plant and equipment increased significantly for mining (including fuels) and for most of the selected mineral manufacturing industries. Expenditures by firms in the mining industry increased over 19% to $3.79 billion; those by all manufacturing firms increased over 4% to $47.95 billion. Expenditures by firms in the primary iron and steel industry showed the largest increase among the selected mineral manufacturing industries; they increased almost 43% to $3.03 billion. Expenditures in the petroleum industry increased over 31% to $10.51 billion, and those in the chemical and allied products industry increased almost 10% to $6.25 billion. Expenditures by firms in two of the selected mineral manufacturing industries declined. Those for the stone, clay, and glass products industry declined over 1% to $1.42 billion, and those for the primary nonferrous metals industry declined more than 2% to $2.28 billion.

Plant and equipment expenditures of

foreign affiliates of U.S. companies increased about 10% in both mining and smelting, and petroleum and declined 3% in manufacturing during 1975. Expenditures in mining and smelting were $1,184 million. Most of this was in Canada, which increased more than 46% over the 1974 value. Mining and smelting investments for plant and equipment declined in all other areas. Petroleum investments totaled $9,370 million. Those in Canada declined over 5%; those in Latin America declined almost 8%; those in Europe increased almost 37%; and those in all other areas, which made up almost one-half of the petroleum investments, increased well over 6%. Manufacturing investments were $11,384 million during 1975. Most of this was invested in Europe, which showed a decline of just over 1%. Investments in Canada declined over 17% and those in Latin America increased almost 17%. Manufacturing investments in all other areas declined over 1%.

Issues of Mining Securities.—Estimated gross proceeds from all corporate primary security offerings in 1975 were $52.6 billion, a 39% increase from those of 1974. Almost 80% of these were from bonds, almost 14% were from common stock, and well over 6% were in preferred stock. Proceeds from offerings in extractive industries increased over 66% to $1.6 billion. More than 53% were from common stock, 42% from bonds, and almost 5% from preferred stock. In the manufacturing sector, proceeds from offerings increased 80% to $18.8 billion. More than 91% were from bonds; 6%, from common stock; and almost 3%, from preferred stock.

Foreign Investment.—Direct foreign investment of U.S. companies abroad increased over 14% to $118.6 billion during 1974 (latest data available). The percentage of petroleum investments received by developing countries remained greater than the percentage of total investments. Investment in developing countries remained at about 24% of total foreign investment, while petroleum investment in developing countries dropped more than 3 percentage points to 27% of total foreign petroleum investment. Petroleum investment in developed countries totaled $18.4 billion. Europe accounted for over 54% of this, and Canada accounted for slightly more than 31%. Petroleum investments in developing countries dropped 2% to $8.2 billion. Of this, countries in the Western Hemisphere accounted for more than 43%; other Africa, slightly over 16%; and the Middle East, almost 20%.

U.S. investments in foreign mining decreased over 18% to $6.1 billion. The largest decrease occurred in Canada, where investment decreased 25%, from $3.7 billion to $2.8 billion. Even with such a drop in investment, Canada accounted for over two-thirds of foreign mining investment in developed countries. Australia ranked second with nearly 24%. Mining investments in developing countries totaled $2.1 billion with almost half going to Latin American Republics.

The value of foreign direct investment in the United States in 1974 (latest data available) was $21.7 billion, an increase of about 19%. Investment in the petroleum sector increased over 27% to $5.9 billion, which was over 27% of the total direct foreign investment in the United States.

TRANSPORTATION

The total quantity of major minerals and mineral energy products transported by rail and water during 1974 (latest data available), decreased by 2.31 million short tons to slightly over 1,720 million short tons. Almost 60% of all commodities transported by rail and over 82% of all commodities transported by water were mineral products. Over 64% of selected metals and minerals, except fuels, were transported by rail, while only about 45% of selected mineral energy resources and related products were transported by rail.

In the metals and minerals, except fuels, category, the volume of commodities transported by rail increased less than 0.1% to 452.3 million short tons. Of this total, over 76% consisted of six commodities: Iron ore and concentrates, crushed and broken stone, iron and steel ingot, sand and gravel, phosphate rock, and iron and steel scrap. The largest percentage decrease was in nonferrous metal scrap, which in 1974 shipped only about 15% of its 1973 tonnage.

Transportation by water for metals and

minerals, except fuels, decreased nearly 3% to 252.4 million short tons. Three commodities accounted for over 76% of the total metals and minerals; they were iron ore and concentrates, crushed and broken stone, and limestone flux and calcareous stone.

A total of 461.6 million short tons of mineral energy resources and related products were transported by rail in 1974; this was 4% greater than that of 1973. By volume the largest commodity shipped was bituminous coal and lignite, which accounted for nearly 84% of the total. Crude petroleum shipped by rail increased nearly 38% from that of 1973.

Water transportation of mineral energy products totaled 554.6 million short tons in 1974, more than 2% below that of 1973. Again, coal accounted for the largest share of tonnage, 26%; followed by residual fuel oil, 20%; gasoline, 16%; and crude petroleum and distillate fuel, each 15%. The largest percentage increase occurred in coke, almost 31%. Significant decreases occurred in jet fuel, 18% and liquefied petroleum gases and coal gases, almost 27%.

A total of 976,700 miles of gas pipeline existed in 1974 (latest data available), an increase of more than 1% from that of 1973. Total petroleum pipeline mileage in 1974 (latest data available), as reported before, was 222,000 miles. It was made up of 31% crude gathering systems in field operations, 34% large size crude trunklines, and 35% petroleum product pipelines extending from refineries to extraction terminals.

RESEARCH ACTIVITIES

Total research and development expenditures in the United States during 1974 (latest data available) were $22.3 billion, almost 7% greater than that in 1973. Following past patterns, almost 63% was spent by the private sector and more than 37% was spent by the Federal Government. Research and development expenditures in the petroleum refining and extractive industries increased almost 19% to $598 million. Almost 97% of these expenditures were privately financed, with the remainder financed by the Federal Government. Expenditures in the chemicals and allied products industries increased more than 13% to $2.4 billion. Almost 91% of these were financed by private industry. During 1973 the percentage of research expenditures financed by private industry was about the same as that of 1974.

Bureau of Mines.—The role of Bureau of Mines research is to foster the efficient use of our mineral resources in order to insure adequate mineral supplies without objectionable environmental, social and economic effects. The Bureau conducts scientific and engineering investigations to improve the recovery of minerals from domestic deposits, to improve the economics of recycling scrap metals, to achieve more efficient utilization of mineral products by extending their lifespan, and to find industrial uses for mineral wastes and thus improve the environment. Bureau research concentrated on the following areas: Mining, metallurgy, secondary resource recovery and pollution abatement, economics and helium.

Bureau of Mines funding obligations for mining and mineral research and development during fiscal year 1975 were $101.6 million. This figure is almost 54% greater than the corresponding 1974 figure. Funds for applied research in fiscal year 1975, at $51.0 million, were more than double those for fiscal year 1974. Funds for basic research declined almost 66% to $1.9 million. Funds for development increased almost 37% to $48.7 million. For fiscal year 1976, obligations were estimated to be $139.0 million, an increase of almost 37%. Funds for applied research in fiscal year 1976 were estimated to increase almost 55% to $79.0 million; for basic research they were estimated to decline almost 53% to $0.9 million; and for development they were expected to increase over 21% to $59.1 million.

Bureau of Mines funding obligations for total research increased more than 73% to $52.9 million during fiscal year 1975. Funds for engineering sciences nearly doubled to $47.7 million; for the physical sciences they declined over 64% to $1.9 million; for the mathematical sciences they increased more than 169% to $1.3 million; and for the environmental sciences they increased almost 143% to $2.0 million. Obligations for total research for fiscal year

1976 were estimated to increase 51% to $79.9 million. For engineering sciences they were estimated to increase almost 55% to $73.9 million; for the physical sciences they were estimated to increase almost 10% to $2.1 million; for the mathematical sciences they were estimated to increase 23% to $1.6 million; and for the environmental sciences they were estimated to increase 17% to $2.4 million. Highlights of Bureau research activities, including work in progress, follow.

Mining.—The full-scale demonstration of shortwall mining in Kentucky continued during 1975. The second, third, and fourth panels were extracted, and development was completed on the fifth and sixth panels. Productivity averaged 583 tons of coal per shift in the fourth panel giving an average of 47 tons per manshift, an increase of 2 tons per manshift over panel three. Production of this shortwall continued to increase with each successive panel. Overall recovery was 85% and productivity by shortwalling was 28% higher than by room-and-pillar methods. Methane control has been simplified, health and safety of the miners increased, and respirable dust concentration at the face averaged only 0.26 milligrams per cubic meter. The shortwall system demonstration has been resulting in high employee morale and acceptance by industry.

The study of single-entry development for longwall mining, which includes measurement of forward and backward abutment pressures, closure and determination of rock properties in the 17th left longwall panel continued. Stiff supports, fiber-reinforced concrete cribs, were installed in a test section to determine if a stiffer support will create a cave line. A three-dimensional structural analysis and field evaluations verified the results that wood cribs do not have the required stability. Advance rates have increased as the result of new configurations, support, and divider systems. The single-entry system illustrated that reduced development time and increased coal recovery are achievable goals, thereby reducing extraction costs.

Work on testing the feasibility of using inorganic materials for grouting roof bolts of steel and other materials was initiated. Lab tests on grout formulations illustrated that a standard ⅝-inch bolt can be pull-tested to a value exceeding its yield strength within 5 to 7 minutes of grouting. Costs of inorganic grout materials are less than current resins used with full column bolts; therefore, the successful demonstration of these grouts will allow industry to reduce support costs.

Development of instrumentation techniques and procedures to determine resin bolt strength parameters was completed. Laboratory tests of instrumentation and two full-scale field test programs have resulted in a complete monitoring program for full column resin bolt sections.

Coal mine bumps and outburst phenomena are being investigated by means of microseismic techniques to identify the release of strain energies prior to the event. This allows for initiation of preventative measures and a lengthening of warning time, thereby increasing the safety conditions in working areas. Several outbursts have been recorded and the resulting data are being processed to identify the prediction signatures that are associated with these phenomena. Coal mine bumps were related to mining activity in a longwall mine whereby microseismic activity correlates with mining cycles and normal levels of microseismic activity can be established therefore providing evidence that bounce locations can be established.

Monitoring of pit wall stability at an open pit mine in Nevada by a microseismic system resulted in identifying a failure zone prior to actual failure. A comprehensive report detailing the method of detection was provided to the mining industry, which now has available a reliable and accurate means of detecting progressive failure in an open pit slope.

Shallow seismic and acoustic reflection techniques were evaluated by means of field tests at working mines to detect channel sands in advance of mining. The value of integrated geophysics using results from remote sensing, seismic resistivity, and magnetics was demonstrated.

An automatic roof failure warning system was installed in a Colorado mine. The collection of microseismic data in the presence of mine machinery noise was successfully demonstrated. System modifications were completed to allow it to work in areas where electric blasting caps were used. The refined system will provide a fully automatic means of providing prior warning to miners of impending failures and thus result in a reduction of injuries from the primary mining hazard, roof falls.

A 1,350-cubic-foot chamber at the Bureau's Pittsburgh Mining and Safety Research Center has been adapted to measure toxic fumes from explosives under conditions simulating those encountered in underground mines. A gelatin dynamite and two water gel blasting agents were fired in the Crawshaw-Jones testing apparatus that simulates restricted expansion after explosion, and also in the 1,350-cubic-foot chamber, to investigate the presence of ammonia in fumes from explosives. Both free and combined ammonia were found. The large chamber values for all three explosives were two to four orders of magnitude higher than the Crawshaw-Jones values. In both tests the water gels produced 3 to 10 times more free ammonia and 2 to 3 times more combined ammonia than the gelatin dynamite.

A personal dosimeter for nitrogen dioxide was developed by the New York University Medical Center as part of a comprehensive Bureau of Mines grant covering passive devices that monitor exposure to CO, NO, and NO_2 in the range near and below the threshold limit value or ceiling limit. The dosimeter is encased in a plastic tube 2½ inches long and clips to a worker's hardhat.

A comprehensive array of detectors and warning systems was being developed to monitor underground atmospheres for hazardous levels of combustion products or potentially explosive substances. The flammability and optical transmission properties of coal dust clouds were being studied; the objective was to develop a monitor that warns when dangerous concentrations of coal dust are in the air. Miniature probes that measure dust cloud concentrations in explosive environments have been developed and found to operate satisfactorily at the Bruceton experimental mine. An infrared device initially developed for detecting methane air ignitions (U.S. Patent 3,859,520) was being incorporated into a general fire detector. Commercial sensors of combustion products were being evaluated and new optical sensors developed. In-Ga-As diodes have been developed that produce radiation at the absorptive band of methane (3.2 microns). These diodes will be used in conjunction with photosensitive diodes having maximum sensitivity at the same wavelength in the construction of an advanced and inherently more reliable methanometer. A dual-band infrared technique has shown great promise for detecting overheated rollers on conveyor belts. Laboratory tests indicate the system can rapidly and reliably detect temperature rises as small as 25° C above ambient.

A lightweight telescopic probe has been developed through which a gas sample from the working face can be pumped into a methanometer located safely under a permanently supported roof. Weighing about 7 pounds, the probe is almost 19 feet long when fully extended. Closed, it is approximately 5½ feet long. Flexible tubing can connect the telescopic probe outlet to either a self-pumping or a diffusion methanometer. An operator can both support the probe and actuate the pump with one hand, leaving the other free to operate the methanometer controls.

In a counterpart research project, a three-port sampling system was developed for installation on a continuous miner, the objective being equipment that provides the operator with measurement of methane gas emissions from various locations on the working face during the coal cutting operation.

In cooperation with a coal company in West Virginia, a low-cost automatic fire protection system was designed and installed on a Compton surface coal auger for a 6-month test period. The system protects engine areas using six thermal sensors and two 30-pound cylinders of ABC-type dry chemical extinguishant. Two manual override switches can also activate the system. The system has been successfully test-fired twice, and the company plans to purchase several upon completion of the test program. An associated project was developing prototype hardware for a load-haul-dump vehicle. Design alternatives available for better protection of mobile underground diesel equipment were developed.

Research into the ignition of methane-air mixtures by sparks from the frictional impact of aluminum alloys on rusted steel at typical coal mine fan speeds was undertaken. Experiments demonstrated that this combination of materials is highly incendive under simulated fan conditions and that some substitute materials might minimize the ignition hazard. This information has been communicated to the Mining Enforcement and Safety Administration (MESA), which is considering draft standards for preventing ignitions from this source.

A mine machinery trainer was being developed as a device for teaching shuttle car operator skills. Component testing of powered and unpowered dynamic models was completed and a motion platform and hazard generator were in the final phase of development.

Information from several past projects provided a basis for applying human engineering principles toward correcting the shortcomings of current operator compartments. This work will provide design and installation guidance to equipment manufacturers and coal mine operators. Design drawings of the operator compartments of 89 machine models for seven major machine types have been modified to optimize the position and location of various controls. This series of drawings illustrates study concepts and recommendations and should be used as guidelines by rebuild shops; they are not engineering drawings that can be immediately used by a manufacturer. This intermediate step was necessary to compensate for specific machine differences. Six machines were being modified by the Bureau using the optimized operator compartment drawings as guidance. It appeared that the concepts can be adapted with few modifications to new machines to be built by manufacturers.

A prototype time domain reflectometer (TDR) that detects faults in trailing cables had been successfully tested, and the Bureau was constructing field test models. Design modifications were in progress to achieve the higher sensitivity and increased range of application needed to locate all faults on a cable from a single setup.

Poor quality grounding creates a safety hazard. Recent difficulties with measuring ground bed resistances indicated a need for simplified and comprehensive instructions on the best techniques available. Step-by-step procedures have been produced that will allow mine electrical personnel, with little or no experience, to build and maintain effective ground beds. A laboratory prototype protective device for detecting low-current trolley line to ground faults in the presence of high current loading was designed and demonstrated for mine haulage systems. The detection system can respond to fault currents that are 0.5% of normal full load current.

The Bureau developed a commercially available fluorescent cap lamp that provides improved light distribution and supplies mine personnel with peripheral vision. This cap lamp is suitable for tasks that do not require long-range spot illumination, providing illumination above the minimum level (0.06 footlambert) at 5 feet over an area 8 to 10 feet wide. It is rechargeable and provides 10 hours of continuous operation per charge.

A fluorescent lighting system for low coal that includes portable area as well as machine-mounted lights was developed and installed on an auger miner. It successfully illuminated working areas to proposed standards for several months and is highly acceptable to operating personnel and management. A lighting system for longwall operations was developed on-site in an existing longwall section in an operating mine, and evaluation results were used to produce an improved illumination system.

A miniaturized monitoring and telemetry system was developed that monitors methane, ventilation, carbon monoxide, and temperature levels within a mine and computes the rate of temperature rise. The monitoring station is housed underground in an enclosure approximately the size of a loudspeaking telephone. Monitored results are displayed underground and telemetered to a small surface console as well. The system was installed and is being tested in a mine. An advanced underground monitoring and communication system was designed and fabricated for testing in a mine. The system monitors face, section, and haulageway air, provides through-the-earth emergency communications at key locations in the mine escapeway, electromagnetically detects and locates trapped miners, incorporates a computer-controlled coaxial cable telephone and monitoring capacity of 200 communication channels, and has alternate communication paths through mine power cables surfacing through boreholes and wireless overland radio for surface transmission. About 80% of the equipment had been installed.

Ten-minute and 1-hour oxygen breathing systems have been developed and approved for use in underground mines. Efforts during the year were directed at seeking higher density oxygen sources that will enable reduction in the size and weight of the 1-hour device.

During 1975 two improved communications systems for rescue teams were developed. One employs a versatile, lightweight radio (walkie-talkie) that uses a detached small-diameter wire between the radios as a wave guide. The other system consists of a hands-free microphone and ear speaker mounted on the rescue helmet. A relatively lightweight wire connects the fresh air base with rescue team units. A miniaturized signal generator powered by a miner's cap lamp battery was developed for the belt-mounted electromagnetic miner location system. The unit, approximately 1.3 by 3.5 by 0.3 inches, or one-tenth the previous size, will be packaged for mounting on a miner's belt. The waveform generator was being modified to receive voice communications from the surface and to transmit "yes" or "no" type coded signals.

A handheld infrared viewer operating in the 3- to 5-micron range was fabricated and evaluated at the Bureau's Experimental Mine. Clear images of men were obtained through dense coal smoke over a distance of 250 feet, showing excellent potential for locating miners trapped in smoke-filled entries. This technology will be applied to development of a borehole probe smoke viewer for rescue teams using solid-state infrared viewers.

A 10-pound ice-based prototype cooling vest, compatible with rescue worker backpack breathing apparatus, was designed and fabricated. Laboratory tests in a hot environment indicated that the cooling vest significantly reduces heat stress experienced by rescue team workers.

The principal effort to control noise was directed at reducing it at its source. A lightweight, inexpensive, add-on system of integral muffler-enclosure for a 75-pound class stoper drill received widespread acceptance by drill operators and appeared to suffer few maintenance problems while reducing the noise level from about 115 decibels on the A scale (dbA) to 100 dbA. An assessment of noise control of underground diesel-powered mining equipment in metal and nonmetal mines identified the significant noise sources, determined the feasibility of reducing the noise levels, and evaluated control techniques for possible application. In a demonstration project for one class of machine, the noise level at the operator's position of a Getman dispatch vehicle was reduced from 101 dbA to 87 dbA.

The preliminary design of a mechanical method for handling supplies and materials in underground coal mines to minimize manual handling and related accidents was completed. The system includes special containers and pallets for supplies and materials, mine cars for transporting these packages, and self-propelled equipment for unloading and transporting the packages to the point of use. A feasibility study of an automated rail haulage system for underground coal mines was completed. The study concluded that automation of rail haulage systems was technically and economically feasible. It also indicated a 50% reduction in fatalities and a 50% reduction in injuries due to rail haulage if the rail haulage portion of underground bituminous mines was automated. Based on fatality and injury data for the years from 1968 to 1973, inclusive, these reductions would annually eliminate an average of 9 fatalities and 400 injuries attributable to rail haulage.

Construction was completed and underground tests initiated on a new conventional mining system. The system consists of four closely integrated pieces of equipment. The coal is cut by a unique fullface, twin auger machine that offers a unique sump-cycle capable of 16 feet of penetration while the operator is always under supported roof. Coal is transported away from the face by a specialized load-haul-dump unit that offers speed, ease of operation, and a design that stresses safety. Coal is discharged at the belt line by a special belt feeder that can easily handle the large car load and can disperse the load at any desired rate. The roof is supported either by a new roof truss system utilizing wire rope or by conventional roof bolts installed by a Roofroper. The four machines together form a complete, safe, and economical system.

A study to determine the state-of-the-art of underground hydraulic mining systems throughout the world was completed. This study cataloged all available data on these systems, identified the application of these systems to U.S. coal deposits, and recommended future hydraulic mining research. The results of this study will be useful in developing a mining system that both mines and transports the coal hydraulically.

In the area of in-mine entry development, boring operations commenced at a mine where a Bureau modified tunnel boring machine will ultimately drive a 6,000-foot-long, 18-foot-diameter entry to open up a virgin area of the Pittsburgh coal seam for longwall panel development. Boring operations indicated that excavation rates of 100 feet per day can be achieved once all support systems designed for the project are incorporated. An in-seam miner developed outside the Bureau completed initial in-mine equipment trials, demonstrating tremendous potential as a rapid in-seam entry driving unit. In preparation for a subsequent demonstration, a number of improvements in design were incorporated on the machine, and action was initiated to obtain support equipment to expedite advance rates.

In the area of shaft construction, development was initiated on a blind shaft borer capable of mechanically excavating 24-foot-diameter shafts and placing lining at rates far in excess of conventional methods. Conservative estimates of the system's performance are the construction of 25 feet of lined shaft per day—a representative average figure for conventionally sunk shafts is approximately 45 feet per month. A system for remote placement of shotcrete lining in raised bored shafts was developed. Placement rates of 30 feet per hour are anticipated without the need for men in the shaft. Work was completed on the fabrication and shop-testing of a conical boring device expected to have the capability of rapid excavation of 42-inch-diameter blind shafts without the aid of thrust applied by a drill rig. To test the results obtained in Europe against U.S. conditions, the Bureau purchased a set of shield-type supports and entered into an agreement for trials to be conducted at a mine in New Mexico.

Shield-type supports had been purchased and were to be installed on a longwall face at a mine in southern Illinois where six previous attempts to longwall had failed. Results in Europe with this type of support indicate that it can successfully operate in conditions adverse to chock-type support operation.

The Bureau contracted with the National Aeronautics and Space Administration (NASA) to conduct research into longwall shearer guidance and control problems and to make recommendations regarding the development of equipment that will allow remote control and eventual automation of the machine cutting and loading functions. The first task which NASA was to embark upon was an examination of all or any means for remotely detecting the coal rock interface. This is a problem that to date has not been successfully solved eleswhere in the world where research and development has been attempted.

The Bureau has embarked upon a program to collect data on the behavior of strata associated with longwall working so that more accurate support design parameters may be defined.

A state-of-the-art review on remote control for continuous miners was completed that documented the opinions and judgement of experienced senior coal mining people on automated remote control continuous mining machines.

Industrial engineering studies on conventional and continuous mining sections passed their respective contract midpoints. Preliminary results indicated mines with a definite mining plan have better productivity. This preliminary result initiated two competitive procurement projects for fiscal year 1976 that will deal with improved techniques for supervisory management and maintenance management.

The design and fabrication of a shortwall face haulage system for transporting coal continuously from a continuous miner to a panel belt was completed. The system consists of a 150-foot-long face chain conveyor and a 200-foot-long monorail-mounted transfer belt conveyor. The inby end of the transfer conveyor is equipped with a self-propelled crawler-mounted tail drive section that will be used to move the transfer conveyor as the shortwall is retreated and to drive the belt conveyor. The system was to be demonstrated in an underground mine and was expected to increase shortwall production and productivity significantly by replacing the currently used intermittent shuttle car haulage method.

An industrial engineering study of coal

haulage in room-and-pillar mines was completed. Among the recommendations made to improve production, productivity, and cost were proper selection of shuttle car routes, better timing of panel belt moves, development of shuttle cars with higher payload to overall vehicle volume ratios, development of continuous haulage equipment with the capability of negotiating right-angle turns and eliminating spillage, development of alternative power sources for shuttle cars to eliminate trailing cables, and improvement of the equipment and methods for advancing and retreating the panel belt tail section.

The goal of increasing production through utilization of a more nearly continuous mining cycle was pursued through design and development work on miner-bolter systems. One concept incorporates both the miner and four automated bolter modules on one machine. The other uses a conventional miner followed by a bolter module that also transfers the coal to a following conveyor system.

In addition, design work continued on an automated bolter module. This unit has the potential of being mounted on a conventional drilling machine. Final design and component manufacture of the flexible drill concept (the ability to drill longer-than-seam-height roof bolt holes) was carried out by five contractors. These systems should reduce roof bolting time and increase mine safety.

A major cost-sharing contract was awarded for design, development, and demonstration of a top slicing method utilizing longwall techniques for recovery of thick seam coal. If the design and feasibility studies are favorable, the system will be demonstrated at a mine in Utah. A request for letter proposals was issued for underground mining concepts applicable to thick and multiple seam western coal deposits. The most promising of these concepts will be candidates for further development and possible demonstration. A study of the spontaneous combustion problem associated with western underground coal mining was also initiated.

Development of a fourth foam dispenser and an inert gas generator system to extinguish mine fires was nearing completion. A working model of the foam dispenser was undergoing refinement to eliminate the possibility of feedline corrosion induced by heat from the foam formula. The gas generator unit was under fabrication and field demonstration of the complete system was planned.

The advancement of subsidence engineering technology to alleviate surface damage in undermined areas continued to gain momentum in 1975. Prototype instrumentation was devised to monitor ground movement, and this equipment was utilized to study the mechanics of overburden adjustment over both longwall and room-and-pillar coal mines.

In addition, the Bureau demonstrated more expeditious methods of premining exploration to reduce the cost of developing detailed subsurface information needed for effective subsidence control. Geophysical instrumentation was miniaturized to permit the measurement of numerous geologic characteristics with a single downhole probe. The multipurpose probe can be used in small-diameter borings. Data collection was further expedited by a computerized read-out system that facilitates rapid interpretation of the geologic logs. A working model of this unit was fabricated in 1975 and demonstration is underway.

The subsidence control research effort was further expanded in 1975 by a search for inexpensive backfill material with cementitious properties. Attention was directed toward various mixtures of mine refuse, fly ash, and other industrial wastes.

Two field tests demonstrated the successful use of long horizontal holes from the bottom of a shaft to degasify the Pittsburgh coalbed ahead of mining and simultaneously make the methane available as a source of energy. At one shaft, 728 million cubic feet of pipeline-quality gas had been removed after 1,150 days of degasification; at the other shaft 686 million cubic feet had been produced after 818 days.

A simple dust method test was developed for determining the gas content of a coal core sample.

Two major advanced mining systems are under construction. The first, a prototype borehole mining system, will use a water jet to break the coal and a slurry pump to lift the broken coal to the surface. The second, an underground auger panel extraction system, consists of an underground augering machine, coal conveyors, and auxiliary ventilation and rock dusting equipment, and will be used to mine out prepared panels of coal at low cost and high recovery rates, and to "second mine" or "rob" pillars in seams that have been mined by room-and-pillar methods.

A small-scale economic and engineering evaluation of underspoil haulage of coal out of strip pits was completed. The study showed significant benefits for using a conveyor inside a culvert buried in the advancing spoil pile for coal haulage if used in thick seams typical of western surface mines. Substantial studies and laboratory experimentation were also conducted in preparation for development of both high-volume, low-pressure and low-volume, high-pressure water jet mining systems. A number of small studies were also undertaken of various new mining system concepts that may eventually result in full-scale development.

A wire rope fatigue testing machine was being constructed as part of a project to extend the service life of ropes used in large draglines. The machine will exert loads of a half million pounds while cycling the ropes through 20 feet of stroke around 90-inch-diameter sheaves, and its 3-inch-diameter rope capability exceeds that of any other such machine known. Along with improvements to existing equipment such as this, new equipment concepts were also being explored. One new concept was a 15-foot-tall vertical blade that is pulled along the coal or overburden face by two tractor dozers. The coal overburden that is sliced off falls onto a conveyor that can load either trucks or other conveyors.

A family of new reclamation tools that will enable operators to level spoil banks faster and at lower cost was being tested. The tools included a 40-foot fixed angle blade, a 24-foot V-plow, a 24-foot grading bar, a 28-foot angle blade utilizing side-by-side crawler tractors, and a 60-foot angle blade with variable angle capabilities. The purpose of the blades is to move spoil material a short distance laterally to the outslope of the spoil banks. Field tests proved the 40-foot blade to be more efficient for moving up to 80% of this material than conventional dozing.

Design was initiated of a surface test facility for testing underground mining equipment under simulated conditions above ground. This facility will help speed the development and introduction of improved technology and will be used to thoroughly test and evaluate new equipment, systems, and procedures prior to their use underground. The facility will be located at the Bureau's Bruceton, Pa., Mining and Safety Research Center, which is convenient to the majority of mining equipment manufacturers. It will have four major components, all of which will be available to industry on a cost reimbursement basis: Equipment trials area, roof support research facility, hydraulic transport research and development facility, and coal preparation laboratory and test plant.

Research to develop more productive and environmentally acceptable surface coal mining, extraction, and reclamation systems, initiated in 1974, continued. Studies included assessments of the impact of surface coal mining operations on the environment; development of new surface coal mining concepts to include a terrace pit system, area-longwall mining, and a conveyor overburden haulage system for use in haulback contour mining operations; design of improved overburden handling and spoil segregation techniques; and development of improved reclamation methodologies to facilitate long-term, stable reclamation of mined areas.

In-house research studies on the utilization of fly ash as a spoil amendment and an analysis of the effects of ground vibrations from blasting activities on structural fatigue were conducted. Blasts were monitored at structures located near active coal surface mining operations to determine the associated ground vibration levels and assess any resultant structural damage. Data collected will be used to develop the relationship between ground vibration levels and structural damage. Fly ash studies demonstrated the value of using fly ash as a spoil amendment to neutralize acidic mine spoil and facilitate revegetation.

An exploratory drilling program was initiated in the Piceance Creek Basin of Northwestern Colorado. The objective is to core the deep rich oil shale zones below the Mahogany Zone. Some of these oil shale horizons lie as deep as 2,500 feet and attain thicknesses of 400 to 500 feet.

Extensive waste management studies investigating spent shale were initiated. The physical and chemical properties of retorted shale have been evaluated in the laboratory and numerous before-and-after compaction gradation tests, compaction, and in-place density tests were determined in the field.

The first comprehensive baseline studies on potential surface, underground, and modified in situ mining processes have identified several mining systems, detailed mining plans, and their respective economics. Reliable information to government and industry on which to base sound management decisions relating to oil shale mining and waste disposal was thus provided.

Recent field tests in two deep vein mines showed that slimes in unclassified tailings can be retained and consolidated in primary stopes using electrokinetic methods. Such retention increases the available backfill and eliminates the problem of slime removal. Safety, economy, and efficiency of the method were demonstrated. As a direct result of the Bureau's demonstrations, the mining company has adopted electrokinetic consolidation as a part of normal underground mining practices in these two mines.

An exhaustive review of the underground systems used to handle men, materials, and supplies was completed. The problem areas associated with the systems were defined both from the safety hazard and production delay standpoints. Two areas presenting the greatest problems were found to be the vertical handling systems underground and the unnecessary movement of men and materials. The study recommends corrective measures for both as well as research goals for the future.

Structural analysis capabilities have been extended to the prediction of the behavior of a mine structure composed of rock strata whose elastic and strength properties are randomly distributed. Predictions of mine structure response can be made on a probabilistic basis, taking the scatter usually encountered in measured rock properties into account, rather than ignoring it as is done in conventional analysis.

A study of the assessment of damage from repeated blast-induced ground vibrations produced evidence of fatigue damage to structures from repeated vibrations at levels that were too low to produce damage from single occurrences.

Experiments with aluminum-sensitized water gels, using aluminum treated with Teflon to render it dustless (Harshaw Process), showed that the special grades of aluminum required for explosive sensitization can be treated in this way without any appreciable loss of effectiveness as sensitizers. This could reduce or eliminate the explosion hazard associated with the use of aluminum in the manufacture of explosives.

Techniques developed to identify explosives after detonation appear applicable to two problems: The identification of clandestine use of explosives and the control of the use of nonpermissible explosives in gassy mines. The experimental phase of the program was successfully completed with a full-scale field experiment in a mine in which commercially seeded explosives were used in production blasting for a period of several weeks. Individual batches of permissible and nonpermissible explosives were readily identified and distinguished following the blasting operation.

Metallurgy.—The general objective of the Metallurgy program is to provide, through research and development, the scientific and technical information necessary to encourage and stimulate the nonfuel minerals industry to make the expeditious advances in technology that will encourage the industry to produce an adequate supply of mineral raw materials at acceptable material and energy costs, and with a minimum of waste and environmental degradation.

The Bureau's miniplant for testing and evaluating processes for the recovery of alumina from domestic nonbauxitic resources continued operation at Boulder City, Nev. This cooperative project, with the support and advice of the alumina consuming industry, considered six potential processes. These included nitric acid, hydrochloric acid, and sulfurous acid processes for the extraction of alumina from clay and processes for treating anorthosite, alunite, and dawsonite. Operation of the nitric acid miniplant had been completed and the plant placed on standby. Installation of the hydrochloric acid miniplant was nearly complete. Additional installations were planned for the remaining processes.

Studies continued on methods of concentrating domestic nonmagnetic iron resources. Certain nonmagnetic taconites from the Marquette range and the Western Mesabi were successfully treated using a selective flocculation-cationic collector flotation process. The prospects of additional applications of this process, following the pattern of the Tilden, Mich. plant, appeared promising. In related work, a procedure was developed for reducing the silica content of magnetic iron ore concentrate by the use of flotation. The process developed by the Bureau produces concentrates suitable for making prereduced iron pellets that may be used in electric furnace operation.

Dump leaching was becoming increasingly important as a source of copper. Bureau of Mines personnel developed an improved method of constructing dumps for leaching. They discovered that, for most ores tested, the copper content of the fine-sized portion is appreciably higher than that of the coarse ore. Consequently, it was found that preliminary coarse crushing and screening out of the fine material, before forming the dump, permits it to be leached more efficiently and rapidly. The fines separated are sent to the flotation mill for recovery of the copper; byproduct metals that would not be recovered by leaching are also recovered by the flotation method. Evaluations indicated that for many ores the extra cost of crushing, screening, and handling may be more than compensated by increased metal recovery.

With the depletion of sulfide ores, laterite oxide deposits have been increasingly utilized as a source of nickel. Singmaster and Breyer, under a Bureau of Mines contract, completed phase I of a study to determine the technical and economic feasibility of the Bureau's extraction process utilizing low-grade domestic western laterite ores. The study, based on a 5,000-ton-per-day commercial-scale plant for extracting nickel, cobalt, and copper, found that the process is technically feasible and that, depending upon financing structure, the process could provide a modest return on equity. The open file report (OFR 65–76) is available for inspection at the Bureau's Metallurgy Research Centers and is available from the National Technical Information Service (PB 256 574/AS).

In cooperation with the Florida State Bureau of Geology, the Bureau of Mines performed characterization studies of the phosphate-bearing Hawthorn Formation that underlies the phosphate land pebble region of Florida. The formation is estimated to contain 2 to 4 billion tons of P_2O_5 at a concentration of 5%, which is lower than the average of 14.7% P_2O_5 that has been mined domestically. The Hawthorn Formation has not been mined because of the lack of a suitable beneficiation procedure. However, the Bureau of Mines has been able to obtain concentrates containing up to 31.8% P_2O_5 by a fatty acid flotation process. The results indicate that this vast phosphate resource will be usable as a raw material source for phosphate fertilizer when present reserves are exhausted.

The Bureau of Mines assisted the Energy Research and Development Administration (ERDA) by developing improved materials for use in ERDA's Synthane plant, which converts coal to high-Btu gas. Materials have been prepared and tested for use as valve seats, ceramic liners, and Raney nickel catalyst structures. The abrasive nature of coal and char has resulted in very short lives for valves used in coal gasification equipment. The Bureau demonstrated the successful coating of 10-inch valve seats by chemical vapor deposition of tungsten, but successful valve seat-wear performance in ERDA test facilities was achieved with homogeneous materials such as modified Stellite No. 6 and a high-chromium iron in 10-inch and smaller valves of alternate design. A catalytic conversion step is used to upgrade the low-Btu gas produced in most coal gasification processes into high-Btu, pipeline-quality fuel. The catalyst, known as Raney nickel, is derived from a brittle aluminum-nickel alloy which has had to be applied to the reactor surfaces by the slow process of flame spraying. The Bureau of Mines developed a procedure for preparing shaped Raney nickel castings that may be inserted directly into tubular reactors. The castings have significantly longer life than the sprayed catalyst.

A critical compilation, "Thermodynamic Properties of Nickel and Its Inorganic Compounds," (BuMines Bulletin 668) was published. The bulletin contains information on basic thermodynamics for metallurgical reactions over extended ranges of temperature. It is organized in both tabular and equation form for ease of use and contains a cross-referenced formula index and a bibliography. The Bureau of Mines published Information Circular 8700 "Uranium From the Chattanooga Shale," which assesses the problems involved in mining the Gassaway Member in a 12-county area of Tennessee. The report estimates uranium resources to be 4.2 to 5.1 million tons contained in 76 to 91 billion tons of shale. Mining, costs, and land disturbance problems are discussed.

Work to produce a more nearly anhydrous magnesium chloride from $MgCl_2 \cdot 6H_2O$ without the formation of magnesium oxide continued. Procedures for the decomposition of organic amine hydrochloride, which may be obtained in the anhydrous state more readily, were improved to obtain a $MgCl_2$ product containing 0.32% oxygen and 0.66% amine hydrochloride. The Bureau continued its cooperative program of testing clay specimens submitted by State geologists in cooperating States. In the last 5 years nearly 3,000 samples from 31 States have been processed. The testing program identifies sources of raw materials for products used by local construction industries.

Bureau studies were underway to determine the most economical method of extracting manganese from deep sea nodules. Research turned to the recovery of manganese as well as cobalt, nickel, and copper, because of the role of manganese as a strategic metal.

Secondary Resource Recovery and Pollution Abatement.—The Bureau of Mines process for recovering values from municipal raw refuse was adopted by Baltimore County, Md., Montgomery County, Md., and Monroe County (Rochester), N.Y. The process recovers ferrous and nonferrous metals, glass, and a combustible fraction. The 400-ton-per-day Baltimore County raw refuse plant was under construction and was to begin operation in 1976. The plants in Montgomery and Monroe Counties were in the design phase and were expected to open in 1977 and 1978, respectively. In addition, the Spanish Government built a pilot plant based on the Bureau's raw refuse technology and planned to build two full-size facilities. Other cities, including Tampa and St. Petersburg, Fla., were working with the Bureau to determine the feasibility of adopting this process.

Technology developed by the Bureau of Mines for incinerating junk cars without producing smoke was being used commercially by over two dozen companies across the country. The low-cost smokeless incinerating system, which was designed by the Bureau's Salt Lake City Metallurgy Research Center, features a large garage-like burner equipped with an afterburner chamber, which heats combustion gases to more than 1,350° F, and a tall stack. Once burned, the junk cars can be dismantled for their metal values and the scrap sorted, baled, and bundled for sale and reuse.

Mixtures of ferrous scrap reclaimed from municipal refuse and shredded auto scrap were successfully melted in the Bureau's basic-lined cupola to produce gray iron. The scrap was obtained as a magnetic fraction from a municipal refuse reduction plant. Satisfactory castings can be obtained with up to 75% refuse scrap using a 5.5/1 scrap/coke ratio. The castings made with 75% refuse scrap were low in carbon, but this difficulty may be overcome by charging with additional coke. Tramp elements in the castings were not objectionably high with furnace charges containing up to 90% refuse scrap.

Sulfur, which could become more abundant as stack gas desulfurization becomes more widespread, was studied by the Bureau for use in paving and construction materials. Methods have been developed for preparing, placing, and evaluating sulfur-sand-asphalt mixtures. Sulfur may replace up to 52 weight-percent of the asphalt. The addition of sulfur produces a paving that is considerably more resistant to attack by petroleum fuels. Test sections were placed on public streets and highways and were being evaluated in cooperation with the municipality of Boulder City, Nev.

A process development unit was assembled to demonstrate the recovery of chromium and other values from waste solutions such as those obtained during the etching of copper-printed circuit boards and brass mill products. The first step in processing such wastes is the reduction of hexavalent chromium to the trivalent state, normally a costly chemical process. In the process development unit this is accomplished, at a considerable saving, by the use of waste paper. The unit then further processes this solution to recover zinc, chromium, and copper. The Bureau-developed waste-plus-waste process was adopted by a Kansas City, Mo., firm. In this process, alkaline cyanide electroplating wastes are neutralized with acid waste solutions such as pickle liquors to precipitate metal cyanide and hydroxides. The solutions obtained have low residual cyanide and metals. The precipitate may be treated pyrometallurgically to recover its metal values.

As a part of the Bureau of Mines research on tailings stabilization, vegetation having a high tolerance for metal salts continued to be sought. Several species of grasses, brought to the United States from Africa, recently were grown in the laboratory on untreated tailings. The grasses appear to be ideal for tailings stabilization work. To take advantage of the desirable qualities of these grasses while avoiding possible undesirable effects, attempts will be made to cross the African grasses with American species to obtain metal-salt-resistant grasses having other desirable properties.

Extended life for American phosphate deposits and reduced slime pollution problems were the goals of the Bureau's new direct sulfuric acid digestion process. The process produces waste suitable for reclaiming mined-out areas rather than the slime generated in conventional processing, and yields up to half again as much phosphoric acid from a given amount of ore. Except for its alumina content, the phosphoric acid is comparable to the acid used for the manufacture of fertilizers. Bureau research was continuing to reduce the aluminum content. Work by the State of Florida aimed at determining whether there is a connection between reclaimed phosphate mining lands, and radiation readings reported by the U.S. Environmental Protection Agency (EPA) was supported by the Bureau of Mines. Under the grant, the Florida State Bureau of Geology will inventory some 10,000 acres of mined phosphate lands in central Florida by age, mineralogy, type of mining, and related factors including type of reclamation. The State Bureau will attempt to relate the categories to preliminary radiologic data reported by EPA in September 1975. Soil samples will be collected and analyzed by the Bureau from each category of mined land. The data will aid in establishing which lands are likely to show elevated radiation levels and will also help in developing new reclamation techniques, if necessary, for minimizing radiation exposure.

Economic Analysis.—The Bureau of Mines economic research program continued the study of economic conditions affecting the mineral industries and, in turn, the effect of the mineral sector on the national and international economies. The purpose of this research was to provide decisionmakers with accurate, up-to-date information and analyses useful in reaching conclusions. The economic analysis program attempted to create general methodology necessary for such analysis, as well as information relevant to problem solving in the field of mineral economics. Major long-term research projects included the study and forecasting of demand, supply, and productivity; critical commodity analyses; mineral taxation; financial analysis; mineral transportation; international trade; input-output analysis; mining and land use; waste recycling; measures of economic activities stimulated by the mineral industries; a weekly price report on fuels and minerals; and a monthly report on major minerals. Some of the short-term projects undertaken in 1975 were the following: A study of the financial and corporate structure of U.S. coal companies, an examination of the methodology for determining strategic stockpile levels, the impact of new environmental standards on nonferrous smelting, economic evaluation of ocean mining, impact of the coal strike on raw steel production, economic impact of the oil refinery workers' strike, international commodity agreements, analyses of domestic and international mineral transport, a preliminary evaluation of proposed rail line abandonments in several Northeastern States, costs of various technologies for producing synthetic fuels, impact of natural gas curtailments in the mineral industries, investigation of economic models of the steel industry, cost-benefit analyses, U.S. policy on Arab investment in domestic minerals, and life-cycle analysis of elements in mineral and energy commodities.

Helium.—The Bureau of Mines has managed the Federal helium program in order to supply needed quantities and qualities for both Federal and commercial requirements. Helium is used in many applications for which an alternative material is either unavailable, uneconomic, or hazardous. The Helium Division conducts a worldwide survey to discover and evaluate new sources of helium-bearing natural gas. Research is conducted to improve methods of producing, storing, and using helium.

LEGISLATION AND GOVERNMENT PROGRAMS

Federal activities in the minerals sector dealt with energy as well as new and continuing programs in the areas of taxation, environmental quality, water resources, transportation, and tariffs and duties.

The $2-per-barrel special fee on imported crude oil and certain petroleum products, instituted in early 1975 in order to reduce dependence on imported oil, was discontinued in December. Price controls were maintained on some domestically produced crude oil and natural gas.

Changes in the Internal Revenue Code cut corporate tax liabilities by a gross amount of $4½ billion, including $2¾ billion resulting from liberalization of the investment tax credit. However, owing to repeal of percentage depletion for oil and gas and limitation of credits for U.S. corporations on foreign tax payments and deferral of taxes on income earned abroad, net corporate tax liabilities were reduced by only $2½ billion.

The Tax Reduction Act of 1975 (Public Law 94–12) affected the minerals sector through the following changes in the Internal Revenue Code: Repealed percentage depletion allowance for oil and gas integrated producers; substantially curtailed foreign tax credit benefits for overseas oil and gas operations; provided that any losses incurred on foreign oil-related income will be recaptured against future income by limiting foreign tax credits available; excluded depletable resources (oil, coal, and uranium, among others) from domestic international sales corporations (DISC) tax benefits; limited investment credit on offshore drilling rigs to those located in the northern part of the Western Hemisphere; and increased business investment credit from 7% to 10% (11% in certain instances) and from 4% to 7% for public utilities.

Public Law 94–99 and Public Law 94–133 extended the Emergency Petroleum Allocation Act of 1973 until September 16, 1975, and December 15, 1975, respectively. Public Law 94–163, the Energy Policy and Conservation Act, established a national domestic energy policy designed to increase domestic energy production, reduce consumption, and provide for emergency standby rationing. Price controls were extended 39 months with an immediate rollback of the average price of domestic oil from $8.75 per barrel to a ceiling of $7.66. This price ceiling could rise at a rate equal to the percentage rise in the GNP deflator between preceding quarters. The President could grant an additional 3% increase upon finding that such an increase would stimulate domestic petroleum production. The total price increase may not exceed 10% during the first year and any additional price increases by the President would be subject to disapproval by either House of Congress.

Public Law 94–83 provides that environmental impact statements for major federally-funded state projects, as long as certain criteria are met, may not be deemed legally insufficient solely for the reason that they were prepared by a State. Public Law 94–156 authorized the Secretary of the Interior to engage in feasibility studies of power intertie potentials for improving electric power transmission systems affecting 17 Western States, a geothermal energy utility system for a California city, and several other water projects. Public Law 94–5 authorized an additional $150 million in federally guaranteed loans and $197 million in grants for maintenance and continued services of railroads operating under the Regional Railroad Reorganization Act, the major portion of which will go to the Penn Central Railroad.

Two laws were enacted dealing with the National Commission on Supplies and Shortages (NCSS). Public Law 94–9 extended the deadline for filing its initial report to March 1, 1975. Public Law 94–72 extended the life of the NCSS until October 1, 1976. A listing of mineral related Federal legislation enacted during 1975 follows:

Public Law (P.L.)	Description	Signed into law
Taxes:		
94–12	Tax Reduction Act of 1975.	Mar. 29
Energy:		
94–99	To extend until Nov. 19, 1975, the Emergency Petroleum Allocation Act of 1973.	Sept. 29

Public Law (P.L.)	Description	Signed into law
Energy—Continued		
94–133	To extend for 1 month until Dec. 15, 1975, the Emergency Petroleum Allocation Act.	Nov. 14
94–163	Providing standby emergency authority to assure that essential energy needs of the United States are met.	Dec. 23
Environmental Quality:		
94–62	Authorizing $16.5 million through Sept. 30, 1976, for programs to regulate dumping of certain materials in the ocean waters and study areas to be designated as marine sanctuaries.	July 29
94–83	To clarify the State and Federal roles in preparing federally required environmental impact statements on Federal-aid highway projects.	Aug. 9
94–140	Extending for 2 years, through Sept. 30, 1976, authority of the Environmental Protection Agency to regulate pesticides and related chemicals.	Nov. 28
94–197	To revise the method of providing for public remuneration in the event of a nuclear incident.	Dec. 31
Water Resources:		
94–38	Authorizing funds for fiscal year 1976 for the saline water conversion program.	June 19
94–112	To extend authority for financial assistance to the States for water resource planning.	Oct. 16
94–156	Authorizing the Secretary of the Interior to engage in feasibility investigations of certain potential water resource developments.	Dec. 16
94–181	To amend the Small Reclamation Projects Act so as to improve and perfect programs involving utilization of water and related land resources.	Dec. 27
Public Lands/Land Use:		
94–31	To provide for a study of the enlarged Grand Canyon National Park for its possible inclusion in the wilderness system.	June 10
94–204	To continue until June 30, 1979, authority of the Joint Federal-State Land Use Planning Commission for Alaska.	Jan. 2, 1976
Tariffs and Duties:		
94–75	Providing for the temporary suspension (until Oct. 3, 1975) of the duty on catalysts of platinum and carbon imported for use in producing caprolactam.	Aug. 8
94–76	Providing for temporary suspension (until June 30, 1975) of duty on open-top hopper cars exported for repairs or alterations.	Aug. 8
94–89	Providing for temporary suspension (until June 30, 1978) of duties on zinc-bearing ores and certain other zinc-bearing materials.	Aug. 9
94–108	Extending until June 30, 1978, the period during which certain dyeing and tanning materials may be imported duty free.	Oct. 8
94–120	Suspending duty on natural graphite until June 30, 1978.	Oct. 21
Transportation:		
94–5	Authorizing additional interim funding for maintenance and continued service of railroads operating under the Regional Railroad Reorganization Act.	Feb. 28
94–56	Authorizing funds to carry out the purpose of the Federal Railroad Safety Act and Hazardous Material Transportation Act through Sept. 30, 1976.	July 29
Miscellaneous:		
94–9	Extending from June 30, 1975, until Dec. 31, 1975, certain authority contained in the Defense Production Act of 1950.	Mar. 21
94–42	To extend through Sept. 30, 1975, expiration date of the Defense Production Act and funding authority for the National Commission on Productivity and Work Quality.	June 28
94–152	Extending for 2 years, through June 30, 1977, provisions of the Defense Production Act.	Dec. 16
94–153	To amend the effective date of the Defense Production Act Amendments of 1975.	Dec. 16

The acquisition cost of strategic and critical materials in the national stockpile, as of December 31, 1975, was $2.6 billion with a current market value of $5.3 billion. The acquisition cost of materials in the supplemental and Defense Production Act stockpiles were $1.1 billion and $0.3 billion, respectively, with respective market values of $1.9 and $0.2 billion. The total acquisition cost of these materials was $4.0 billion with a market value of $7.4 billion. Materials in these inventories with an acquisition cost of $3.4 billion and a market value of $6.3 billion were considered to be in excess of stockpile needs. During 1975 disposals from the national and supplemental stockpiles totaled $107.9 million, which is less than 8% of that disposed of in 1974. Disposals from the Defense Production Act inventory and the other inventories were $10.4 million and $155.4 million, respectively, bringing the grand total disposed of to $273.6 million. Commodities with the greatest sales value included gold, $154.5 million; metallurgical manganese, $18.6 million; tungsten ores and concentrates, $18.4 million; and cobalt, $17.3 million.

WORLD REVIEW

World Economy.—In 1975, economic recovery from the worst post-World War II recession began in most major industrial countries. Inflation rates moderated relative to the preceding 3 years but continued at high levels by historical standards. Both unemployment and underutilized industrial capacity increased during the year. Capacity utilization rates for large industrial countries averaged about 75% in 1975. The volume of trade fell significantly worldwide for the first time in 30 years. World agricultural production increases in 1975 (excluding centrally planned economies in Asia, for which complete data are unavailable) were more than offset by world population increases.

Real GNP for the four largest industrial countries in Western Europe, and Canada and Japan declined at an average annual rate of 4.3% for the first half of 1975. For the year as a whole, real GNP declined 1.5% in the United Kingdom, 3.0% in France, 3.4% in West Germany, 4.5% in Italy, remained unchanged in Canada, and increased 2.2% in Japan. Downturns in most of these countries were caused by inventory liquidations; declines in investment in plant, equipment, and housing; and weaknesses in the external sector. These adverse developments stemmed, in turn, largely from the rapid increase in world oil prices since 1973, which was a major cause of the serious recession and slow recovery in oil consuming countries.

The only group of countries where significant growth occurred in 1975 was the Organization of Petroleum Exporting Countries (OPEC). OPEC imports rose sharply compared to 1974 as did the level of its domestic economic activity.

World Production.—The United Nations (UN) indexes of world mineral industry production (1970=100) for the extractive industries decreased 2 index points to 114 in 1975. The metal mining index declined 3 points to 106, the coal index rose 2 points to 98, and the crude petroleum and natural gas index dropped 4 points to 119. Indexes for the mineral processing industries showed declines of 7 points to 114 for base metals, 1 point to 125 for nonmetallic mineral products, and 1 point to 134 for chemicals, petroleum, and coal products. The UN index of overall industrial production fell 1 point to 126 in 1975.

World Trade.—The value of world export trade in all commodities rose 45% to $835.5 billion in 1974 (latest data available). The value of mineral commodity exports for 1974 was $263.1 billion, a 109% increase over the 1973 figure. For metals the value of exports increased more than 53% to $87.3 billion; within this group, iron and steel exports rose 63%, followed by nonferrous metals exports at 46%, and all ores, concentrates, and scrap exports at 40%. Crude nonmetal trade increased 43% to $5.8 billion. Mineral fuel exports rose in value to $170.1 billion, a 161% increase over the 1973 figure.

World Prices.—Mineral commodity export price indexes (1970=100) were somewhat higher in 1975 for all sectors. Metal ores rose by 25 index points to 200, fuels by 11 points to 588, and all crude minerals by 21 points to 494. Total minerals export prices increased 10% in developed areas and 3% in developing areas. Nonferrous base metal prices declined 16% in developed areas and 32% in developing areas.

Table 1.—Value of crude mineral production,[1] exports, and imports, by group
(Million dollars)

Mineral group	1971 Production	1971 Exports[2]	1971 Imports[2]	1972 Production	1972 Exports[2]	1972 Imports[2]	1973 Production	1973 Exports[2]	1973 Imports[2]
Metals and nonmetals except fuels:									
Nonmetals	6,058	226	573	6,482	152	646	7,413	280	768
Metals	3,403	192	1,047	3,642	247	988	4,362	253	1,081
Total[3]	9,461	418	1,620	10,124	399	1,634	11,775	533	1,849
Mineral fuels	21,247	1,020	2,076	22,061	1,108	2,856	25,012	1,155	4,815
Grand total[3]	30,708	1,438	3,696	32,185	1,508	4,490	r 36,787	1,688	6,664

Mineral group	1974 Production	1974 Exports[2]	1974 Imports[2]	1975 Production	1975 Exports[2]	1975 Imports[2]
Metals and nonmetals except fuels:						
Nonmetals	r 8,643	r 533	1,158	9,518	745	1,214
Metals	5,552	343	r 4 1,758	5,196	372	4 1,617
Total[3]	r 14,195	r 876	r 4 2,917	14,714	1,117	4 2,831
Mineral fuels	r 40,937	r 2,665	16,545	47,561	3,557	19,912
Grand total[3]	r 55,131	r 3,542	r 4 19,462	62,275	3,674	4 22,743

r Revised.
[1] For details, see the "Statistical Summary" chapter of this volume.
[2] Essentially unprocessed mineral raw material.
[3] Data may not add to totals shown because of independent rounding.
[4] The value of imports for bauxite was not available.

Table 2.—Value of crude mineral production by group, 1967 constant dollars[1]
(Million dollars)

Mineral group	1971	1972	1973	1974	1975 p
Metals and nonmetals except fuels:					
Nonmetals	5,646	5,762	6,219	6,095	5,374
Metals	2,742	2,861	3,070	2,956	2,640
Total	8,388	8,623	9,289	9,051	8,014
Mineral fuels	17,735	17,075	17,676	17,000	16,614
Grand total	26,123	25,698	26,965	26,051	24,628

p Preliminary.
[1] Value deflated by the index of implicit unit value.

Table 3.—Indexes of the physical volume of mineral production, by group and subgroup [1]
(1967=100)

	1971	1972	1973	1974	1975 p
METALS					
Ferrous	96.9	98.4	116.0	108.3	96.2
Nonferrous:					
Base	151.0	162.8	166.5	159.3	142.7
Monetary	110.6	102.7	94.5	86.9	86.2
Other	115.5	112.6	114.8	122.8	119.5
Average	143.0	151.1	153.6	148.4	134.9
Average, all metals	122.3	127.5	136.8	130.4	117.6
NONMETALS					
Construction	106.2	111.7	120.8	115.2	99.5
Chemical	101.9	108.7	112.2	121.3	115.5
Other	105.5	112.2	122.7	128.6	109.5
Average	105.2	111.0	119.0	117.2	103.6
FUELS					
Coal	98.9	105.9	105.1	107.1	114.3
Crude oil and natural gas	111.3	111.4	109.3	104.1	98.7
Average	109.7	111.2	109.3	105.4	102.2
Average, all minerals	109.9	112.7	114.1	110.4	103.9

p Preliminary.
[1] Historical table of this series in Bureau of Mines Minerals Yearbook, 1971.

Table 4.—Federal Reserve Board indexes of industrial production for mining and selected minerals manufacturing
(1967=100)

	1971	1972	1973	1974	1975 p
Mining:					
Coal	99.8	104.2	104.4	105.1	113.8
Oil and gas extraction:					
Crude oil	108.3	107.3	104.4	99.8	95.0
Natural gas	124.5	126.4	125.9	121.4	110.9
Average [1]	108.9	110.0	108.9	107.7	104.5
Average coal, oil, gas	107.6	109.2	108.3	107.3	105.8
Metal	121.4	120.9	130.8	129.2	121.7
Stone and earth minerals	93.2	98.1	109.5	109.1	101.7
Average	104.6	107.3	118.1	117.2	109.8
Average mining	107.0	108.8	110.3	109.3	106.6
Manufacturing:					
Primary metals	100.9	113.1	127.0	124.0	97.0
Iron and steel	96.5	107.1	121.7	119.9	95.9
Nonferrous metals and products	108.7	[2] 123.6	136.5	131.2	99.3
Clay, glass, stone products	110.0	118.6	129.8	125.5	108.8
Average industrial production	106.8	115.2	125.6	124.7	113.7

p Preliminary.
[1] Includes natural gas liquids, and oil and gas drilling.
[2] Corrected figure.

Source: Federal Reserve System, Board of Governors. Industrial Production, 1971 edition, November 1972, tables A-8, 9. Industrial Production, Statistical Release. Dec. 14, 1973, Dec. 13, 1974, Apr. 15, 1975, Feb. 13, 1976, and Apr. 15, 1976.

Table 5.—Federal Reserve Board monthly indexes of mining production, seasonally adjusted
(1967=100)

Month	Total mining [1]		Coal, oil, gas		Coal		Oil and gas extraction [2]				Metal, stone, earth minerals		Metal mining		Stone and earth minerals	
							Total [3]		Crude oil							
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
January	109.0	107.0	107.0	103.9	108.7	111.3	106.8	102.9	102.4	95.3	121.4	119.1	135.2	133.8	111.9	109.0
February	111.7	108.6	109.6	106.8	112.7	117.5	109.1	105.0	104.2	97.7	119.9	116.2	132.2	131.1	111.6	106.1
March	112.2	108.9	110.2	107.7	114.7	117.4	109.5	106.1	101.3	95.9	119.7	113.4	132.9	125.4	110.7	105.1
April	111.3	108.5	109.8	107.4	110.3	112.2	109.7	106.6	100.6	95.0	117.5	113.3	127.4	125.8	110.7	104.7
May	111.0	105.9	109.2	105.8	112.4	113.6	108.8	104.5	100.2	94.3	117.9	106.2	128.1	114.8	111.0	100.4
June	110.2	106.3	109.7	107.6	118.3	120.4	108.4	105.5	99.8	95.7	112.4	101.5	121.1	110.6	106.4	95.3
July	110.2	106.4	109.4	106.7	115.6	120.6	108.4	104.5	100.4	95.5	113.5	105.0	120.3	110.3	108.8	101.4
August	107.3	105.0	106.7	104.4	99.4	105.7	107.9	104.2	99.5	94.7	109.9	107.2	110.0	119.2	109.9	98.9
September	109.2	105.3	107.7	104.8	112.1	113.6	107.1	103.4	98.8	93.6	115.4	107.2	130.5	118.5	105.0	99.5
October	110.5	106.4	107.8	106.1	110.3	114.6	107.4	104.8	97.5	94.6	121.3	108.0	141.4	119.8	107.5	100.0
November	105.0	106.9	101.2	105.9	67.6	119.9	106.4	103.8	97.6	93.9	120.7	110.0	136.8	122.1	109.8	101.7
December	104.4	105.4	101.1	104.7	85.3	107.8	103.6	104.3	95.3	93.9	117.9	108.2	134.7	120.9	106.4	99.6
Average	109.3	106.6	107.3	105.8	105.1	113.8	107.7	104.5	99.8	95.0	117.2	109.8	129.2	121.7	109.1	101.7

[1] Including fuels.
[2] Category changed in source.
[3] Includes natural gas liquids and oil and gas drilling.

Source: Federal Reserve System, Board of Governors. Federal Reserve, Industrial Production, Statistical Release, Mar. 14, 1975, Mar. 16, 1976, and Apr. 15, 1976.

Table 6.—Net supply of principal minerals by component [1]

(Thousand short tons of mineral content, unless otherwise stated)

Commodity and mineral content measured	Total net supply		Percent change	Components as percentage of gross supply [1]						Exports as percentage of gross supply	
				Primary shipments		Old scrap		Imports			
	1974	1975 p		1974	1975	1974	1975	1974	1975	1974	1975
FERROUS METALS											
Iron ore ---- thousand long tons	130,691	119,901	−8.3	64	62	--	--	36	38	2	2
Pig iron	96,182	79,658	−17.2	100	99	--	--	(2)	1	(2)	(2)
Steel ingot	155,478	125,296	−19.4	90	90	--	--	10	10	4	3
Chromite (Cr_2O_3)	463	420	−9.3	--	--	--	--	100	100	6	e 9
Cobalt ---- thousand pounds	33,635	17,627	−47.6	54	66	--	--	46	34	3 4	9
Manganese	370	561	+51.6	--	--	--	--	100	100	38	27
Molybdenum (ore and concentrate) thousand pounds	39,658	45,126	+13.8	100	98	--	--	(2)	2	3 56	58
Nickel	229	218	−4.8	3 7	7	3 8	7	3 85	86	3 12	12
Tungsten ---- thousand pounds	17,745	10,743	−39.5	41	46	--	--	59	54	6	11
OTHER METALS											
Aluminum	5,147	4,045	−21.4	85	81	4	6	11	12	r 9	10
Antimony	45	36	−20.0	1	2	r 51	e 46	r 48	52	2	1
Cadmium	5	3	−40.0	62	24	--	--	38	76	1	6
Copper	2,689	2,438	−9.3	3 59	58	3 18	15	3 23	27	1	1
Lead	1,485	1,403	−5.5	43	44	45	46	12	10	3 4	1
Magnesium	NA	NA	NA	W	W	NA	NA	NA	NA	NA	NA
Mercury ---- 76-pound flasks	62,196	58,930	−5.3	4	12	13	14	83	74	1	1
Platinum group ---- thousand troy ounces	4,711	2,740	−41.8	36	39	6	8	58	53	15	19
Tin ---- thousand long tons	50	56	+12.0	--	--	32	27	68	73	r 15	7
Titanium concentrate (TiO_2):											
Ilmenite and slag	754	739	−2.0	r 3 58	55	--	--	3 43	45	3 --	--
Rutile	243	NA	NA	--	W	--	--	100	NA	3 1	NA
Uranium concentrate (U_3O_8)	14	13	−7.1	86	92	--	--	14	8	--	(2)
Zinc	1,340	1,045	−22.0	37	45	6	5	57	50	1	1
NONMETALS											
Asbestos	817	602	−26.3	13	16	--	--	87	84	r 7	6
Barite, crude	1,835	1,921	+4.7	3 60	67	--	--	3 40	33	--	--
Bromine ---- thousand pounds	431,176	403,576	−6.4	100	100	--	--	--	(2)	r (2)	1
Clays	58,680	47,111	−19.7	100	100	--	--	(2)	(2)	4	5
Fluorspar, finished	1,531	1,189	−22.3	13	12	--	--	87	88	(2)	(2)
Gypsum	25,985	20,961	−19.3	72	74	--	--	28	26	1	(2)
Mica (excluding scrap)	115	115	--	94	93	--	--	6	7	7	5
Phosphate rock (P_2O_5)	9,767	11,109	+13.7	99	100	--	--	1	(2)	r 31	26
Potash (K_2O equivalent)	6,084	5,076	−16.6	37	36	--	--	63	64	11	13
Salt, common	49,373	42,913	−13.1	93	93	--	--	7	7	1	3
Sand and gravel ---- million tons	904	789	−12.7	100	100	--	--	(2)	(2)	(2)	(2)
Stone, crushed ---- do	1,042	900	−13.6	100	100	--	--	(2)	(2)	(2)	(2)
Sulfur, all forms ---- thousand long tons	10,818	10,603	−2.0	84	84	--	--	16	16	r 20	11
Talc and allied minerals	1,136	830	−26.9	98	98	--	--	2	2	14	16

e Estimate. p Preliminary. r Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data.

1 Net supply is sum of primary shipments, old scrap, and imports minus exports. Stockpile disposals are included in primary shipments. Gross supply is the total before subtraction of exports.

2 Less than ½ unit.

3 Erroneously reported in previous year.

Table 7.—Shipments, net new orders, and yearend unfilled orders for selected mineral processing industries
(Million dollars)

Year and month	Shipments [1]			Net new orders [1]			Unfilled orders at end of period [1]		
	Primary metals	Blast furnaces	All other primary metals [2]	Primary metals	Blast furnaces	All other primary metals [2]	Primary metals	Blast furnaces	All other primary metals [2]
1971	55,083	26,656	28,427	54,537	26,362	28,175	6,043	3,432	2,611
1972	57,941	[3] 28,109	29,832	60,143	29,813	30,330	7,964	5,008	2,686
1973	72,027	35,260	36,767	78,642	39,913	38,729	14,844	9,884	4,960
1974	93,673	47,424	46,249	97,233	49,036	48,197	20,698	13,751	6,947
1975 p	77,651	40,353	37,298	71,112	35,922	35,190	14,084	9,287	4,797
1975:									
January	7,299	4,082	3,217	6,118	3,275	2,843	19,518	12,944	6,574
February	6,992	3,839	3,153	5,594	2,937	2,657	18,120	12,041	6,079
March	6,269	3,378	2,891	4,773	2,156	2,617	16,624	10,819	5,805
April	6,338	3,408	2,930	4,802	2,114	2,688	15,088	9,525	5,563
May	6,022	3,089	2,933	6,010	3,132	2,878	15,077	9,568	5,509
June	5,961	3,043	2,918	5,439	2,761	2,678	14,556	9,286	5,270
July	6,041	2,992	3,049	5,943	2,885	3,058	14,452	9,179	5,273
August	6,424	3,118	3,306	6,397	3,136	3,261	14,424	9,196	5,228
September	6,977	3,717	3,260	6,294	3,168	3,126	13,740	8,647	5,093
October	6,543	3,187	3,356	6,579	3,334	3,245	13,778	8,795	4,983
November	6,415	3,132	3,283	6,472	3,272	3,200	13,836	8,935	4,901
December	6,409	3,343	3,066	6,657	3,695	2,962	14,084	9,287	4,797

p Preliminary.
[1] Monthly figures are seasonally adjusted and may not add to totals.
[2] "All other primary metals" obtained by subtracting blast furnaces from primary metals figures.
[3] Corrected figure.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business. Vs. 54 and 55, No. 2, February 1974 and 1975, pp. S-5, S-6, S-7; V. 56, No. 3, March 1976, pp. S-5, S-6, S-7.

Table 8.—Index of nonfuel mineral stocks at yearend
(1967=100)

	1971	1972	1973	1974	1975 p
Crude minerals, at producers:					
Metals	147	143	95	[1] 76	88
Iron ore	136	113	84	73	90
Other ferrous	275	428	208	130	104
Nonferrous	101	78	63	[1] 53	54
Nonmetals	149	138	129	125	171
Total	148	141	110	98	124
Minerals at manufacturers, consumers, and dealers:					
Metals	[2] 105	[2] 94	[2] 83	[2] 102	116
Iron	99	88	79	79	93
Other ferrous	135	135	99	102	132
Base nonferrous	[2] 114	[2] 99	[2] 89	[2] 131	153
Other nonferrous	96	87	79	111	112
Nonmetals	88	94	91	100	91
Total	[2] 104	[2] 94	[2] 83	[2] 102	115

p Preliminary.
[1] Corrected figure.
[2] Revised copper series.

Table 9.—Physical stocks of mineral energy resources and related products at yearen
(Producers' stocks, unless otherwise indicated)

Fuel	1971	1972	1973	1974	197
Coal and related products:					
Bituminous coal and lignite [1] short tons	89,985,000	116,500,000	103,022,000	95,528,000	127,159,0
Coke do	3,510,000	2,941,000	1,184,000	935,000	4,996,0
Petroleum and related products:					
Carbon black thousand pounds	296,028	237,695	230,325	293,903	231,6
Natural gasoline, plant condensates, isopentane thousand barrels	6,176	6,075	7,835	7,550	7,3
Crude petroleum and petroleum products [2] do	1,037,771	952,904	1,000,472	1,066,096	1,125,57
Crude petroleum do	259,648	246,395	242,395	265,020	271,35
Gasoline do	223,771	217,149	209,395	218,346	234,92
Special naphthas do	5,384	5,232	4,514	5,716	4,37
Liquefied gases [3] do	94,713	85,717	83,086	97,956	105,55
Distillate fuel oil do	190,622	154,319	196,421	200,029	208,78
Residual fuel oil do	59,681	55,216	53,480	59,694	74,12
Petroleum asphalt do	21,202	21,636	15,024	21,370	22,79
Other products do	182,750	167,240	196,074	197,965	203,65
Natural gas [4] billion cubic feet	3,523	3,523	3,906	3,969	4,27

p Preliminary.
[1] Industrial consumers and retail yards.
[2] Includes natural gas liquids.
[3] Includes ethane.
[4] American Gas Association.

Table 10.—Seasonally adjusted book value of product inventories for selected mineral processing industries
(Million dollars)

End of year or month	Petroleum and coal products	Stone, clay, glass products	Primary metals: Blast furnace and steel mills	Primary metals: Other primary metals [1]	Primary metals: Total
1971: December	2,367	2,362	4,913	4,306	9,219
1972: December	2,300	2,463	5,268	4,390	9,658
1973: December	2,626	2,813	4,672	4,684	9,356
1974: December	3,925	3,721	5,747	6,114	11,861
1975:					
December	4,313	3,630	7,627	6,297	13,924
January	4,061	3,760	6,241	6,205	12,446
February	4,210	3,741	6,620	6,395	13,015
March	4,203	3,781	6,920	6,461	13,381
April	4,157	3,773	7,234	6,536	13,770
May	4,066	3,728	7,525	6,589	14,114
June	4,107	3,692	7,769	6,526	14,295
July	4,144	3,651	7,832	6,450	14,282
August	4,158	3,661	7,761	6,329	14,090
September	4,212	3,613	7,498	6,291	13,789
October	4,223	3,613	7,541	6,229	13,770
November	4,301	3,585	7,618	6,280	13,898

[1] Other primary metals figure obtained by subtracting blast furnace figure from primary metals figure.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 53, No. 2, February 1973; v. 55, No. 2, February 1975; v. 56, No. 3, March 1976, p. 5–6.

Table 11.—Value of selected minerals and mineral products imported and exported by the United States in 1975, by commodity group and commodity [1]
(Thousand dollars)

SITC code [2]	Commodity	Exports	Imports
	Minerals, nonmetallic (crude):		
271	Fertilizers, crude	464,027	27,719
273	Stone, sand and gravel	37,811	26,962
274	Sulfur and unroasted iron pyrites	69,679	70,953
275	Natural abrasives (including industrial diamonds)	58,528	54,528
276	Other crude minerals	261,600	262,063
	Total [3]	891,645	442,227
	Metals (crude and scrap):		
281	Iron ore and concentrates	60,071	860,495
282	Iron and steel scrap	779,257	31,776
283	Ores and concentrates of nonferrous base metals	240,236	772,612
284	Nonferrous metal scrap	221,950	160,665
285	Silver, platinum, platinum-group metal ores and concentrates	52,315	134,412
286	Uranium and thorium ores and concentrates	1,840	531
	Total [3]	1,355,669	1,960,495
	Mineral energy resources and related products:		
321	Coal, coke, briquets (including peat)	3,343,033	202,298
331	Petroleum, crude and partly refined	187	19,250,291
332	Petroleum products, except chemicals	936,678	5,515,784
341	Gas, natural and manufactured	214,583	1,435,417
	Total [3]	4,494,481	26,403,791
	Chemicals:		
	Inorganic chemicals:		
513	Elements, oxides, halogen salts	608,177	724,875
514	Other inorganic chemicals	337,751	107,270
515	Radioactive and associated materials except uranium and thorium	315,180	195,477
521	Mineral tar and crude chemicals from coal, petroleum, natural gas	59,286	14,051
	Total [3]	1,320,394	1,041,675
	Minerals, nonmetallic (manufactured):		
661	Lime, cement, fabricated building material, except glass and clay	55,676	116,720
662	Clay and refractory construction materials	136,322	66,177
663	Mineral manufactures, not elsewhere specified	166,138	83,198
	Total	358,136	266,095
	Metals (manufactured):		
671	Pig iron, spiegeleisen, sponge iron, iron and steel powder and shot, ferroalloys	73,768	556,962
672	Iron or steel ingots and other primary forms	63,296	69,523
673	Iron or steel bars, rods, angles, shapes, sections	181,007	941,513
674	Iron or steel universals, plates, sheets	328,304	1,727,527
675	Iron or steel hoops and strips	62,310	67,400
676	Iron or steel rails and railway track construction materials	70,557	29,662
677	Iron or steel wire (excluding wire rod)	25,340	231,551
678	Iron or steel tubes, pipes, fittings	1,411,949	1,040,241
679	Iron or steel castings and forgings, unworked	240,637	30,852
681	Silver, platinum, and platinum-group metals	222,906	517,675
682	Copper and copper alloys	332,569	418,615
683	Nickel and nickel alloys	117,944	464,306
684	Aluminum and aluminum alloys	433,210	410,598
685	Lead and lead alloys	12,041	47,488
686	Zinc and zinc alloys	17,335	283,880
687	Tin and tin alloys	12,344	315,740
688	Uranium and thorium metals and alloys	203	5
689	Miscellaneous nonferrous base metals	164,039	122,007
	Total [3]	3,769,759	7,275,554
	Grand total	12,190,084	37,389,837

[1] Data in this table are for the indicated SITC numbers only, and therefore may not correspond to the figures classified by commodity in the "Statistical Summary" chapter of this volume.
[2] Standard Industrial Trade Classification.
[3] Import data may not add to totals shown because of independent rounding.

Source: U.S. Department of Commerce, Bureau of the Census.

Table 12.—Percentage distribution of the value of exports of selected minerals and mineral fuels and related products in 1975, by area of destination

SITC code [1]	Commodity	North America [2]	South America	Europe, excluding centrally planned economies	Europe, centrally planned economies [3]	Asia, excluding centrally planned economies	Asia, centrally planned economies [4]	Africa	Oceania	Undesignated areas
271	Fertilizers, crude	28	7	25	6	34	--	--	--	--
273	Stone, sand and gravel	85	4	6	(5)	4	--	1	(5)	--
274	Sulfur and unroasted iron pyrites	2	20	69	--	5	--	1	3	--
275	Natural abrasives, including industrial diamonds	13	5	63	(5)	14	(5)	2	3	--
276	Crude minerals, not elsewhere specified	27	6	41	(5)	21	(5)	2	2	(5)
281	Iron ore and concentrates	99	(5)	(5)	--	1	--	--	--	--
282	Iron and steel scrap	20	6	31	(5)	41	2	(5)	(5)	--
283	Ores and concentrates of nonferrous base metals	10	3	68	4	15	(5)	(5)	(5)	(5)
284	Nonferrous metal scrap	13	3	49	(5)	34	--	1	(5)	--
286	Uranium and thorium ores and concentrates	--	--	100	--	--	--	--	--	--
321	Coke, coal, briquets, including peat	22	6	28	1	43	(5)	(5)	(5)	--
331	Petroleum, crude and partly refined	96	--	4	--	--	--	--	--	--
332	Petroleum products, except chemicals	26	10	35	1	20	(5)	5	3	(5)
341	Gas, natural and manufactured	70	(5)	(5)	(5)	29	--	1	(5)	(5)
513	Inorganic chemical elements, oxides, halogen salts	39	24	14	2	11	(5)	4	5	1
514	Other inorganic chemicals	31	20	22	(5)	16	1	4	4	2
515	Radioactive and associated materials	11	(5)	69	(5)	20	--	(5)	(5)	--
521	Mineral tar and crude chemicals from coal, petroleum, natural gas	15	3	63	--	14	--	2	1	2
661	Lime, cement, fabricated building materials except glass and clay	60	3	20	1	12	(5)	1	(5)	3
662	Clay and refractory construction materials	52	12	15	1	8	1	3	1	7
663	Mineral manufactures, not elsewhere specified	39	7	30	1	11	1	4	4	3
671	Pig iron, sponge iron, iron or steel powders and shot, ferroalloys	54	7	30	1	6	(5)	1	1	--
672	Iron and steel ingots and other primary forms	62	15	12	--	4	--	7	(5)	--
673	Iron and steel bars, rods, angles, shapes, sections	52	17	9	(5)	14	1	6	1	--
674	Iron and steel plates and sheets	43	22	9	3	16	1	5	1	--
675	Iron and steel hoop and strip	43	18	29	--	6	(5)	2	2	--
676	Iron and steel rails and railway track construction material	46	37	1	(5)	13	--	2	1	--
677	Iron and steel wire (except insulated electric)	44	9	23	1	15	1	5	2	--
678	Iron and steel tubes, pipes, fittings	20	14	11	(5)	37	1	16	1	--
679	Iron and steel castings and forgings (rough)	80	2	9	(5)	7	--	1	1	--
681	Silver, platinum, platinum-group metals	15	2	63	(5)	15	--	4	(5)	(5)
682	Copper and copper alloys	15	15	59	(5)	9	(5)	1	1	--
683	Nickel and nickel alloys	33	6	48	(5)	10	(5)	(5)	2	--
684	Aluminum and aluminum alloys	30	7	26	1	21	11	3	1	--
685	Lead and lead alloys	13	10	65	2	7	1	1	(5)	--
686	Zinc and zinc alloys	18	21	52	--	6	(5)	2	1	--
687	Tin and tin alloys	55	24	17	(5)	3	--	(5)	(5)	--
688	Uranium and thorium and their alloys	26	(5)	28	--	34	--	--	12	--
689	Base metals and alloys not elsewhere specified	22	8	51	(5)	16	--	2	1	(5)

[1] Standard Industrial Trade Classification.
[2] Includes Trinidad and Netherlands Antilles.
[3] The U.S.S.R., Bulgaria, East Germany, Albania, Czechoslovakia, Hungary, Poland, Romania, Yugoslavia, Estonia, Latvia, Lithuania.
[4] The People's Republic of China, North Korea, North Vietnam, South Vietnam, Laos, Cambodia, Mongolia.
[5] Less than ½ unit.

Source: U.S. Department of Commerce, Bureau of the Census.

Table 13.—Percentage distribution of imports of principal minerals and mineral fuels and related products in 1975, by area of origin

SITC code [1]	Commodity	North America [2]	South America	Europe, excluding centrally planned economies	Europe, centrally planned economies [3]	Asia, excluding centrally planned economies	Asia, centrally planned economies [4]	Africa	Oceania
2713000	Phosphate, crude and apatite	100	--	--	--	--	--	--	--
2732100	Gypsum	99	--	1	--	--	--	--	--
2743000	Sulfur	100	--	(5)	--	--	--	--	--
2752400	Natural abrasives	5	--	87	--	1	--	7	--
2762200	Graphite, natural	30	(5)	15	9	13	15	18	--
2762500	Magnesia, refractory and caustic-calcined, and crude magnesite	(5)	--	90	6	2	(5)	--	1
2763000	Salt	98	1	1	--	--	--	--	--
2764000	Asbestos	88	--	(5)	2	--	--	10	--
2765200	Mica, including scrap	16	6	1	--	72	--	5	--
2765420	Fluorspar	73	1	20	--	1	--	5	--
2769300	Barite, crude	27	33	24	2	(5)	--	14	--
2769500	Talc	17	--	57	--	26	--	(5)	--
2810000	Iron ore and concentrates	49	43	1	(5)	(5)	--	6	--
2820000	Iron and steel scrap	82	(5)	1	--	17	--	--	(5)
2831100	Copper ores and concentrates	68	9	(5)	(5)	20	--	--	2
2833000	Bauxite	65	25	(5)	(5)	(5)	--	(5)	9
2834000	Lead ores and concentrates	62	20	--	--	--	--	--	18
2835000	Zinc ores and concentrates	93	4	(5)	--	2	--	--	1
2836000	Tin ores and concentrates	--	100	--	--	--	--	--	--
2837000	Manganese ores and concentrates	2	39	--	--	--	--	48	11
2839100	Chrome ores	--	--	19	44	15	--	22	--
2839200	Tungsten ores and concentrates	29	30	5	--	21	7	2	6
2839310	Tantalum, molybdenum, vanadium ores and concentrates	55	23	2	--	3	--	9	8
2839320, 2839330	Titanium ores and concentrates	4	--	--	--	1	--	(5)	95
2839340	Zirconium ores	1	--	--	--	11	--	2	86
2839910	Antimony ores and needles	28	29	7	--	6	1	28	1
2839920	Beryllium ores and concentrates	--	60	6	--	--	--	34	--
2839930	Columbium ores and concentrates	1	60	5	--	22	1	11	--
2840200	Copper waste and scrap	87	(5)	6	1	5	--	(5)	1
2840300	Nickel waste and scrap	68	--	28	--	3	--	--	1
2840400	Aluminum waste and scrap	68	(5)	16	15	1	(5)	--	--
2840500	Magnesium waste and scrap	13	--	55	15	9	--	7	1
2840600	Lead waste and scrap	98	--	1	--	--	--	--	1
2840700	Zinc waste and scrap	67	2	26	--	--	--	--	5
2840900	Tin waste and scrap	8	--	91	--	1	--	--	(5)
2850140, 2850240	Platinum-group metal ores, concentrates, waste	47	12	33	--	(5)	--	3	5
2860000	Uranium and thorium ores and concentrates	--	--	--	--	100	--	--	--
3214000, 3218000, 3219000	Coal, coke, briquets	9	--	82	2	1	--	5	1

See footnotes at end of table.

Table 13.—Percentage distribution of imports of principal minerals and mineral fuels and related products in 1975, by area of origin—Continued

SITC code [1]	Commodity	North America [2]	South America	Europe, excluding centrally planned economies	Europe, centrally planned economies [3]	Asia, excluding centrally planned economies	Asia, centrally planned economies [4]	Africa	Oceania
3310000	Petroleum, crude and partly refined	22	12	1	(5)	34	--	31	--
3320000	Petroleum products, except chemicals	55	23	6	3	8	--	4	1
3410000	Gases, natural and manufactured	91	4	(5)	--	1	--	4	--
5132500	Mercury, including waste and scrap	31	3	32	11	--	1	22	--
5136500	Alumina	32	12	5	--	(5)	--	--	51
5210000	Mineral tar and crude chemicals from coal, petroleum, and natural gas	18	--	80	(5)	2	--	(5)	--
5613000	Potassic fertilizers and fertilizer materials	93	(5)	3	(5)	2	--	1	--

[1] Standard Industrial Trade Classification.
[2] Includes Trinidad and Netherlands Antilles.
[3] The U.S.S.R., Bulgaria, East Germany, Albania, Czechoslovakia, Hungary, Poland, Romania, Yugoslavia, Estonia, Latvia, Lithuania.
[4] The People's Republic of China, North Korea, North Vietnam, South Vietnam, Laos, Cambodia, Mongolia
[5] Less than ½ unit.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. General Imports. FT 135, December 1975, table 2, customs value.

Table 14.—Consumption of major mineral products, mineral fuels, and electricity 1974, 1975, and projections

Commodity	1974	1975 p	2000
MINERAL PRODUCTS			
Ferrous metals:			
Iron ore ---- thousand long tons --	138,160	114,126	NA
Iron content ---- thousand short tons --	e 95,900	e 79,250	NA
Raw steel (production) ---- do ----	145,720	116,783	NA
Chromite ores (gross weight):			
Metallurgical grade ---- do ----	904	532	NA
Refractory grade ---- do ----	295	183	NA
Chemical grade ---- do ----	251	166	NA
Manganese ore (35% or more Mn) ---- do ----	1,880	1,819	3,900
Molybdenum (Mo content) ---- thousand pounds --	63,476	51,689	188,000
Tungsten (W content) ---- do ----	16,298	14,012	76,400
Nonferrous metals:			
Aluminum (apparent consumption) thousand short tons --	5,918	4,737	28,400
Antimony, primary ---- short tons --	18,041	12,987	48,000
Copper, refined ---- thousand short tons --	2,194	1,535	7,100
Lead, primary and secondary ---- do ----	1,599	1,297	2,730
Zinc, all classes ---- do ----	1,673	1,232	3,090
Mercury, primary ---- 76-pound flasks --	59,479	50,838	102,000
Platinum-group metals ---- thousand troy ounces --	1,981	1,310	3,157
Silver (industrial consumption) ---- do ----	176,027	157,650	420,000
Ilmenite and titanium slag (estimated TiO_2 content) short tons --	683,533	536,994	1,840,000
Uranium (U_3O_8, estimated purchases by private industry) do ----	11,900	12,500	73,113
Nonmetals:			
Asbestos (apparent consumption) - thousand short tons --	846	605	2,430
Cement (apparent consumption) ---- million short tons --	83	72	NA
Clays (apparent consumption) ---- thousand short tons --	61,087	49,388	174,000
Lime (sold or used) ---- do ----	21,606	19,133	NA
Phosphate rock (P_2O_5 content, apparent consumption) do ----	14,946	10,315	NA
Potash (K_2O content, apparent consumption) -- do ----	6,084	5,076	14,455
Salt (apparent consumption) ---- do ----	49,373	42,913	158,900
Sand and gravel ---- million short tons --	979	789	3,200
Stone, crushed (sold or used) ---- do ----	1,044	901	3,400
Sulfur, all forms (apparent consumption) thousand long tons --	10,818	10,603	30,000
MINERAL ENERGY RESOURCES AND ELECTRICITY			
Bituminous coal ---- million short tons --	553	555	1,000
Coal carbonized for coke [1] ---- do ----	(90)	(83)	(115)
Anthracite ---- do ----	5	5	2
Petroleum production and natural gas liquids million barrels --	6,078	5,954	14,500
Natural gas, dry [2] ---- million cubic feet --	21,223	19,538	49,000
Electricity generation, net ---- million kilowatt hours --	1,967,699	2,003,028	NA
Utilities ---- do ----	1,866,414	1,918,126	[3] 8,650,000
Hydropower [4] ---- do ----	313,741	307,660	[3] [5] 605,000
Nuclear power ---- do ----	113,577	171,925	[3] 5,085,000
Conventional fuel-burning plants ---- do ----	1,451,790	1,444,726	[3] 2,960,000
Industrial ---- do ----	101,286	84,902	NA
Total energy resources inputs ---- trillion Btu --	72,668	70,558	[3] 163,430

e Estimate. p Preliminary. NA Not available.
[1] Figures in parenthesis are not added to totals.
[2] Residual gas excludes extraction loss but includes transmission loss.
[3] Dupree, W. G., Jr., and J. S. Corsentino. U.S. Energy Through Year 2000 (revised). U.S. Department of the Interior. December 1975, tables 1 and 15.
[4] Net generations adjusted for net imports or exports. The bulk of net trade is hydropower with an undetermined amount of steam plant power.
[5] Includes power produced at geothermal plants.

Table 15.—Production of mineral energy resources and electricity from hydropower and nuclear power

(Trillion Btu)

Year	Anthracite	Bituminous coal and lignite [1]	Natural gas, wet (unprocessed)	Crude petroleum [2]	Electricity [3] Hydropower	Electricity [3] Nuclear power	Total
1971	222	13,385	24,805	20,033	2,825	404	61,674
1972	181	14,319	24,792	20,041	2,866	576	62,775
1973	174	14,208	r 24,764	19,493	2,860	888	r 62,387
1974	168	14,319	23,689	18,575	3,177	1,211	61,139
1975 p	158	15,228	22,022	17,729	3,165	1,833	60,135

p Preliminary. r Revised.

[1] Heat values employed for bituminous coal and lignite are as follows: 1971, 12,120 Btu per pound; 1972, 12,025 Btu; 1973, 12,005 Btu; 1974, 11,865 Btu; and 1975, 11,750 Btu.

[2] Heat value employed for crude petroleum is 5,800,000 Btu per barrel, based upon an approximate API gravity of 36°, which is generally accepted as the average value of crude oil produced in the United States.

[3] Hydropower and nuclear power include installations owned by manufacturing plants and mines as well as Government and privately owned public utilities. The fuel equivalent of hydropower is calculated from the kilowatt-hours generated, converted to theoretical energy resources inputs calculated from national average heat rates for fossil-fueled steam-electric plants provided by the Federal Power Commission. Those heat rates are as follows: 10,478 Btu per net kilowatt-hour in 1971; 10,379 Btu in 1972; 10,389 Btu in 1973; 10,442 Btu in 1974; and 10,383 Btu in 1975. The fuel equivalent of nuclear power is calculated similar to hydropower, using an average heat rate of 10,660 Btu per net kilowatt-hour based on information from the Energy Research and Development Administration.

Table 16.—Calculated gross consumption of mineral energy resources and electricity from hydropower and nuclear power in British thermal units (Btu) and percent contributed by each [1]

Year	Anthracite	Bituminous coal and lignite	Coke [2]	Natural gas, dry	Petroleum (excluding natural gas liquids)	Natural gas liquids	Electricity Hydropower	Electricity Nuclear power	Total
TRILLION BTU									
1971	186	11,857	--	r 22,469	28,045	2,525	2,862	404	r 68,348
1972	150	12,273	--	r 22,698	30,382	2,584	2,946	576	r 71,609
1973	144	13,150	--	r 22,512	32,276	2,576	r 3,009	888	r 74,555
1974	138	12,751	59	21,733	30,988	2,479	3,309	1,211	72,668
1975 p	130	12,684	14	19,948	30,338	2,382	3,229	1,833	70,558
PERCENT									
1971	0.3	17.3	--	r 32.9	r 41.0	3.7	r 4.2	0.6	100.0
1972	.2	17.1	--	r 31.7	r 42.4	3.6	4.2	.8	100.0
1973	.2	17.6	--	r 30.2	r 43.3	r 3.5	4.0	1.2	100.0
1974	.2	17.5	0.1	29.9	42.7	3.4	4.5	1.7	100.0
1975 p	.2	18.0	([3])	28.3	43.0	3.4	4.5	2.6	100.0

p Preliminary. r Revised.

[1] Heat values employed are as follows: Anthracite, 12,700 Btu per pound and bituminous coal and lignite, weighted average British thermal units provided by the Division of Coal; 11,980 Btu per pound in 1971; 11,875 in 1972; 11,825 in 1973; 11,535 in 1974; and 11,400 in 1975. Btu values for petroleum products obtained by using 5,248,000 Btu per barrel for gasoline; 5,355,000 Btu per barrel for naphtha-type jet fuel; 5,670,000 Btu for kerosine and kerosine-type jet fuel; 5,825,000 Btu for distillate; 6,287,000 Btu for residual; 6,065,000 Btu for lubricants; 5,537,000 Btu for wax; and weighted average for all products applied to miscellaneous. Natural gas dry, 1,031 Btu per cubic foot in 1971; 1,027 in 1972; 1,021 in 1973; 1,024 in 1974; and 1,021 in 1975; natural gas liquids, weighted average British thermal units: Natural gasoline and other products, 110,000 Btu per gallon; LPG 95,500 Btu per gallon; ethane, 73,390 Btu per gallon; and plant condensate 129,000 Btu per gallon beginning in 1973. The fuel equivalent of hydropower is calculated from the kilowatt-hours generated and imported, converted to theoretical energy inputs calculated from national average heat rates for fossil-fueled steam-electric plants provided by the Federal Power Commission as follows: 10,478 Btu per net kilowatt-hour in 1971; 10,379 in 1972; 10,389 in 1973; 10,442 in 1974; and 10,383 in 1975. Energy inputs for nuclear power are converted at an average heat rate of 10,660 Btu per net kilowatt-hour based on information from the Energy Research and Development Administration.

[2] Energy from net imports of coke (2,262,000 tons in 1974 and 546,075 tons in 1975 at 13,000 Btu per pound). The remainder of coke consumption is accounted for in utilizing the gross total Btu value of coal carbonized for coke.

[3] Less than ½ unit.

Table 17.—Consumption of energy resources, by major sources and consuming sector

(Trillion Btu)

Sector and year	Anthracite	Bituminous coal and lignite	Coke [1]	Natural gas, dry [2]	Petroleum [3]	Hydropower [4]	Nuclear power [5]	Utility electricity [6]	Total
Final consuming sectors:									
Household and commercial:									
1971	98	308	--	r 7,713	r 6,430	--	--	3,209	r 17,758
1972	75	233	--	r 7,943	r 6,666	--	--	3,478	r 18,395
1973	74	222	--	7,633	6,697	--	--	r 3,723	r 18,349
1974	66	232	--	7,518	6,099	--	--	3,726	17,641
1975 p	57	189	--	7,589	5,752	--	--	3,970	17,557
Industrial:									
1971	47	4,256	--	r 9,874	r 5,088	34	--	2,293	r 21,592
1972	35	4,240	--	r 9,882	r 5,643	35	--	2,493	r 22,328
1973	33	4,344	--	r 10,454	6,076	38	--	r 2,644	r 23,589
1974	35	4,035	59	10,018	5,909	33	--	2,670	22,759
1975 p	35	3,772	14	8,551	5,517	35	--	2,580	20,504
Transportation: [7]									
1971	NA	6	--	766	r 16,304	--	--	17	r 17,093
1972	NA	4	--	787	r 17,290	--	--	17	r 18,098
1973	NA	3	--	744	18,192	--	--	r 15	r 18,954
1974	NA	2	--	685	17,734	--	--	16	18,437
1975 p	NA	1	--	595	17,933	--	--	16	18,545
Miscellaneous and unaccounted for:									
1971	--	--	--	--	r 205	--	--	--	r 205
1972	--	--	--	--	233	--	--	--	233
1973	--	--	--	--	231	--	--	--	231
1974	--	--	--	--	245	--	--	--	245
1975 p	--	--	--	--	278	--	--	--	278
Total final consumption:									
1971	145	4,570	--	18,353	28,027	34	--	[8] 5,519	[9] 56,648
1972	110	4,477	--	18,612	29,832	35	--	[8] 5,988	[9] 59,054
1973	107	4,569	--	18,831	31,196	38	--	[8] 6,382	[9] 61,123
1974	101	4,269	59	18,221	29,987	33	--	[8] 6,412	[9] 59,082
1975 p	92	3,962	14	16,735	29,480	35	--	[8] 6,566	[9] 56,884
Energy conversion sector:									
Electricity generation (utilities):									
1971	42	7,288	--	4,117	2,543	2,828	404	[8] −5,519	[10] 11,703
1972	40	7,796	--	4,086	3,134	2,911	576	[8] −5,988	[10] 12,555
1973	37	8,581	--	3,681	3,656	2,971	888	[8] −6,382	[10] 13,432
1974	38	8,482	--	3,512	3,480	3,276	1,211	[8] −6,412	[10] 13,587
1975 p	38	8,722	--	3,213	3,239	3,194	1,833	[8] −6,566	[10] 13,673

See footnotes at end of table.

Table 17.—Consumption of energy resources, by major sources and consuming sector—Continued

(Trillion Btu)

Sector and year	Anthracite	Bituminous coal and lignite	Coke [1]	Natural gas, dry [2]	Petroleum [3]	Hydropower [4]	Nuclear power [5]	Utility electricity [6]	Total
Total resources consumed: [11]									
1971	186	11,857	--	r 22,469	30,570	2,862	404	--	r 12 68,348
1972	150	12,273	--	r 22,698	32,966	2,946	576	--	r 12 71,609
1973	144	13,150	--	r 22,512	34,852	3,009	888	--	r 12 74,555
1974	138	12,751	59	21,733	33,467	3,309	1,211	--	12 72,668
1975 p	130	12,684	14	19,948	32,720	3,229	1,833	--	12 70,558

p Preliminary. r Revised. NA Not available.

[1] Energy from net imports of coke (2,262,000 tons in 1974 and 546,075 tons in 1975). The remainder of domestic coke consumption is accounted for in utilizing the gross total Btu value of coal carbonized for coke.

[2] Excludes natural gas liquids.

[3] Petroleum products including still gas, LPG, and natural gas liquids.

[4] Outputs of hydropower (adjusted for net imports) are converted to theoretical energy inputs using national average heat rates for fossil-fueled steam-electric plants provided by the Federal Power Commission. The heat rates are as follows: 1971, 10,478 Btu per net kilowatt-hour; 1972, 10,379; 1973, 10-389; 1974, 10,442; and 1975, 10,383.

[5] Energy inputs for nuclear powerplants are calculated using an average heat rate of 10,660 Btu per kilowatt-hour, based on information from the Energy Research and Development Administration.

[6] Excludes electricity generated by non-utility plants, the energy inputs to which are included in the other inputs of the final consuming sectors. Distribution to sectors is based on sales reported in the annual issues of the Edison Electric Institute Statistical Yearbook of the Electric Utility Industry. Conversion of electricity to energy equivalent by sectors was made at the theoretical value of contained energy of 3,412 Btu per kilowatt-hour.

[7] Includes bunkers and military uses.

[8] Utility electricity, generated and imported, distributed to the final consuming sectors.

[9] Also termed "net energy inputs."

[10] Conversion losses in the electricity generation (utilities) sector. Total energy inputs to this sector is the sum of conversion losses and utility electricity distributed (footnote 8).

[11] Data may not add to totals shown because of independent rounding.

[12] Also termed "gross energy inputs."

Table 18.—Domestic supply and demand for coal

	1974		1975 p	
	Thousand short tons	Trillion Btu	Thousand short tons	Trillion Btu
ANTHRACITE				
Supply:				
Production [1]	6,617	168.1	6,200	157.5
Exports [2]	−1,169	−29.7	−1,092	−27.8
Imports	--	--	--	--
Stock change: Withdrawals (+), additions (−)	NA	NA	NA	NA
Losses, gains, and unaccounted for	--	--	--	--
Total	5,448	138.4	5,108	129.7
Demand by major consuming sectors: [3]				
Household and commercial [4]	2,577	65.5	2,240	56.9
Industrial [5]	1,373	34.9	1,386	35.2
Electricity generation, utilities	1,498	38.0	1,482	37.6
Total	5,448	138.4	5,108	129.7
BITUMINOUS COAL AND LIGNITE				
Supply:				
Production [1]	603,406	14,318.8	648,000	15,228.0
Exports	−59,926	−1,618.0	−65,669	−1,773.0
Imports	2,080	48.0	940	21.4
Stock change: Withdrawals (+), additions (−)	7,265	158.0	−31,765	−687.1
Losses, gains, and unaccounted for	−116	−155.8	4,795	−105.6
Total	552,709	12,751.0	556,301	12,683.7
Demand by major consuming sectors:				
Fuel and power:				
Household and commercial [4]	8,840	232.0	7,282	188.5
Industrial [5]	149,619	3,927.6	142,072	3,677.2
Coal carbonized for coke [6]	(89,747)	(2,355.9)	(83,272)	(2,155.3)
Transportation [7]	80	2.1	24	.6
Electricity generation, utilities	390,068	8,481.6	403,249	8,722.3
Total	548,607	12,643.3	552,627	12,588.6
Raw Material: Industrial: [8]				
Crude light oil	1,087	28.5	974	25.2
Crude coal tar	3,015	79.2	2,700	69.9
Total	4,102	107.7	3,674	95.1
Grand total	552,709	12,751.0	556,301	12,683.7

p Preliminary. NA Not available.
[1] Includes use by producers for power and heat.
[2] Includes shipments to U.S. Armed Forces in West Germany.
[3] Except for small quantities used as raw material for coal chemicals, all anthracite is used for fuel and power.
[4] Data represent "retail deliveries to other consumers." These are mainly household and commertial users, with some unknown portion of use by small industries.
[5] Includes consumption by coke plants, steel and rolling mills, and other industrial uses. Adjusted to exclude coal equivalent of raw material use.
[6] Figures in parenthesis are not added into totals.
[7] Includes bunkers and military transportation.
[8] Coal equivalent based on British thermal unit value of raw material consumption of coal chemicals listed.

Table 19.—Domestic supply and demand for natural gas

	1971 r		1972 r		1973 r		1974		1975 p	
	Million cubic feet	Trillion Btu	Million cubic feet	Trillion Btu	Million cubic feet	Trillion Btu	Million cubic feet	Trillion Btu	Million cubic feet	Trillion Btu
Supply:										
Marketed production [1]	22,493,012	24,805.0	22,531,698	24,791.8	22,647,549	24,763.6	21,600,522	23,689.3	20,108,661	22,022.2
Transfers out, extraction loss [2]	−883,127	−2,525.1	−907,993	−2,584.3	−916,551	−2,576.2	−887,490	−2,479.2	−872,282	−2,381.8
Domestic production [3 4]	(21,609,885)	(22,279.9)	(21,623,705)	(22,207.5)	(21,730,998)	(22,187.4)	(20,713,032)	(21,210.1)	(19,236,379)	(19,640.4)
Exports	−80,212	−82.7	−78,013	−80.1	−77,169	−78.8	−76,789	−78.6	−72,675	−74.2
Imports	934,548	963.5	1,019,496	1,047.0	1,032,901	1,054.6	959,284	982.3	953,008	973.0
Stock change: Withdrawals(+), additions(−)	−331,768	−342.1	−135,734	−139.4	−441,504	−450.8	−83,663	−85.7	−344,054	−351.3
Transmission loss and unaccounted for [5]	−338,999	−349.5	−328,002	−336.8	−195,863	−200.0	−288,731	−295.6	−235,065	−240.0
Total	21,793,454	22,469.1	22,101,452	22,698.2	22,049,363	22,512.4	21,223,133	21,732.5	19,537,593	19,947.9
Demand by major consuming sectors:										
Fuel and power:										
Household and commercial [6]	7,480,667	7,712.6	7,733,964	7,942.8	7,476,424	7,633.4	7,341,745	7,518.0	7,432,417	7,588.5
Other consumers [4 6]	(336,278)	(346.7)	(321,421)	(330.1)	(308,996)	(315.5)	(292,708)	(299.7)	(240,160)	(245.2)
Industrial [5]	8,928,513	9,205.3	8,968,720	9,210.9	9,539,747	9,740.1	9,073,235	9,291.0	7,699,094	7,860.8
Transportation (pipeline fuel)	742,592	765.6	766,156	786.8	728,177	743.5	668,792	684.8	582,963	595.2
Electricity generation, utilities	3,992,983	4,116.8	3,978,673	4,086.1	3,605,333	3,681.0	3,429,231	3,511.5	3,146,873	3,213.0
Total	21,144,755	21,800.3	21,447,513	22,026.6	21,349,681	21,798.0	20,513,003	21,005.3	18,861,347	19,257.5
Raw material (industrial): [7]										
Carbon black	63,699	65.7	53,939	55.4	49,682	50.7	40,130	41.1	26,246	26.8
Other chemicals [8]	585,000	603.1	600,000	616.2	650,000	663.7	670,000	686.1	650,000	663.6
Total	648,699	668.8	653,939	671.6	699,682	714.4	710,130	727.2	676,246	690.4
Grand total	21,793,454	22,469.1	22,101,452	22,698.2	22,049,363	22,512.4	21,223,133	21,732.5	19,537,593	19,947.9

p Preliminary. r Revised.

[1] Marketed production represents gross withdrawals less gas used for repressuring and the quantities vented and flared. British thermal unit value of production is for wet gas prior to extraction of natural gas liquids. Higher Btu values assigned to extraction loss represent the Btu value of natural gas liquids production for each year.

[2] Extraction loss from cycling plants represents offtake of natural gas for natural gas liquids as reported to the Bureau of Mines. Energy equivalent of extraction loss is based on annual outputs of natural gasoline and associated products at 110,000 Btu per gallon, annual outputs of LPG at 95,500 Btu per gallon, annual outputs of ethane, since 1967, at 73,390 Btu per gallon, and beginning with 1973, energy equivalent for plant condensate is computed at 129,000 Btu per gallon.

[3] Domestic production is the marketed production less the shrinkage resulting from the extraction of natural gas liquids.

[4] Figures in parenthesis are not added into totals.

[5] Transmission loss and unaccounted for was formerly included in the industrial sector.

[6] Includes deliveries to municipalities and public authorities for institutional heating, street lighting, etc., formerly included in the industrial consuming sector.

[7] Includes some fuel and power used by raw material industries.

[8] Estimated from partial data.

NOTE.—Conversion factors for dry gas are as follows: 1971, 1,031 Btu per cubic foot; 1972, 1,027; 1973, 1,021; 1974, 1,024; and in 1975, 1,021.

Table 20.—Domestic supply and demand for petroleum [1]

	1974		1975 p	
	Million barrels	Trillion Btu	Million barrels	Trillion Btu
Supply:				
Crude oil:				
Production	3,202.6	18,575.0	3,056.8	17,729.3
Exports	−1.1	−6.2	−2.1	−12.2
Imports	1,269.2	7,361.4	1,498.2	8,689.6
Stock change: Withdrawals (+), additions (−)	−22.5	−130.5	−6.3	−36.5
Losses, transfers for use as fuel, and unaccounted for	−19.5	−113.2	−5.2	−30.1
Total	4,428.7	25,686.5	4,541.4	26,340.1
Refinery inputs:				
Crude oil	4,428.7	25,686.5	4,541.4	26,340.1
Transfers in, natural gas liquids [2]	272.4	1,245.3	259.3	1,172.2
Other hydrocarbons	13.1	45.9	13.8	48.3
Total	4,714.2	26,977.7	4,814.5	27,560.6
Refined products:				
Refinery output	4,714.2	26,977.7	4,814.5	27,560.6
Unfinished oil reruns, net	37.4	217.9	12.7	74.0
Processing gain, net	175.2	--	167.8	--
Total	4,926.8	27,195.6	4,995.0	27,634.6
Exports [3]	−79.4	−461.3	−74.3	−424.4
Imports [3]	961.8	5,747.2	700.8	4,157.9
Stock change, including natural gas liquids	−42.8	−231.6	−53.0	−256.5
Transfers in, natural gas liquids [2,4]	343.7	1,233.9	336.7	1,209.6
Losses, gains, and unaccounted for	−31.9	−16.5	48.8	398.5
Total	6,078.2	33,467.3	5,954.0	32,719.7
Demand by major consuming sectors:				
Fuel and power:				
Household and commercial	888.2	4,933.5	854.4	4,738.4
Industrial	628.9	3,692.2	610.2	3,548.5
Transportation [5]	3,270.2	17,577.1	3,310.9	17,795.6
Electricity generation, utilities	559.9	3,480.2	520.1	3,239.3
Other, not specified	18.5	111.6	16.4	98.3
Total	5,365.7	29,794.6	5,312.0	29,420.1
Raw material: [6]				
Petrochemical feedstock offtake	386.2	1,640.6	340.6	1,434.2
Other nonfuel use	302.2	1,898.4	268.7	1,685.7
Total	688.4	3,539.0	609.3	3,119.9
Miscellaneous and unaccounted for	24.1	133.7	32.7	179.7
Grand total	6,078.2	33,467.3	5,954.0	32,719.7

p Preliminary.

[1] Supply and demand for crude oil and petroleum products. Petroleum products include products refined and processed from crude oil, including still gas and liquefied refinery gas; also natural gas liquids transferred from natural gas.

[2] Btu values for natural gas liquids for each year shown are implicitly derived from weighted averages of major natural gas liquids, with natural gasoline and other products at 110,000 Btu per gallon, liquefied petroleum gases at 95,500 Btu per gallon, ethane at 73,390 Btu per gallon, and plant condensate at 129,000 Btu per gallon.

[3] Btu values for imported and exported refined products for each year shown are totals of the Btu values of the respective products imported and exported.

[4] Includes natural gas liquids other than those channeled into refinery input as follows: Petrochemical feedstocks, direct uses for fuel and power, and other uses.

[5] Includes bunkers and military fuel uses.

[6] Includes some fuel and power use by raw materials industries.

Table 21.—Petroleum consumption, by major product and major consuming sector [1]

	Household and commercial		Industrial		Transportation [2]		Electricity generation, utilities		Miscellaneous and unaccounted for		Total domestic product demand	
	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu
1974												
Fuel and power:												
Liquefied gases	172.2	690.7	[3] 56.0	224.6	31.2	125.1	--	--	--	--	259.4	1,040.4
Jet fuels:												
Naphtha type	--	--	--	--	81.2	434.8	--	--	--	--	81.2	434.8
Kerosine type	--	--	--	--	276.2	1,566.0	5.2	29.5	--	--	281.4	1,595.5
Total	--	--	--	--	357.4	2,000.8	5.2	29.5	--	--	362.6	2,030.3
Gasoline	--	--	--	--	2,402.4	12,607.8	--	--	--	--	2,402.4	12,607.8
Kerosine	49.9	282.9	14.5	82.2	--	--	--	--	--	--	64.4	365.1
Distillate fuel	493.2	2,872.9	126.6	737.4	366.5	2,134.9	79.5	463.1	10.1	58.8	1,075.9	6,267.1
Residual fuel	172.9	1,087.0	194.0	1,219.7	112.7	708.5	475.2	2,987.6	8.4	52.8	963.2	6,055.6
Still gas	--	--	175.7	1,054.2	--	--	--	--	--	--	175.7	1,054.2
Petroleum coke	--	--	62.1	374.1	--	--	--	--	--	--	62.1	374.1
Total	888.2	4,933.5	628.9	3,692.2	3,270.2	17,577.1	559.9	3,480.2	18.5	111.6	5,365.7	29,794.6
Raw material: [4]												
Plant condensate	--	--	6.1	33.0	--	--	--	--	--	--	6.1	33.0
Special naphthas	--	--	32.0	167.9	--	--	--	--	--	--	32.0	167.9
Lubes [5] and waxes	--	--	37.7	225.1	25.8	156.5	--	--	--	--	63.5	381.6
Petroleum coke [6]	--	--	25.0	150.6	--	--	--	--	--	--	25.0	150.6
Asphalt and road oil	175.6	1,165.3	--	--	--	--	--	--	--	--	175.6	1,165.3
Petrochemical feedstock offtake:												
Liquefied refinery gas [7]	--	--	41.9	162.3	--	--	--	--	--	--	41.9	162.3
Liquefied petroleum gas [7] [8]	--	--	211.8	739.6	--	--	--	--	--	--	211.8	739.6
Naphtha (—400°)	--	--	61.9	324.9	--	--	--	--	--	--	61.9	324.9
Still gas	--	--	14.4	86.4	--	--	--	--	--	--	14.4	86.4
Miscellaneous (+400°)	--	--	56.2	327.4	--	--	--	--	--	--	56.2	327.4
Total	175.6	1,165.3	487.0	2,217.2	25.8	156.5	--	--	--	--	688.4	3,539.0
Miscellaneous and unaccounted for	--	--	--	--	--	--	--	--	24.1	133.7	24.1	133.7
Grand total domestic product demand	1,063.8	6,098.8	1,115.9	5,909.4	3,296.0	17,733.6	559.9	3,480.2	42.6	245.3	6,078.2	33,467.3
1975 p												
Fuel and power:												
Liquefied gases	167.1	670.2	[3] 67.7	271.6	27.7	111.1	--	--	--	--	262.5	1,052.9

See footnotes at end of table.

Table 21.—Petroleum consumption, by major product and major consuming sector [1]—Continued

	Household and commercial		Industrial		Transportation [2]		Electricity generation, utilities		Miscellaneous and unaccounted for		Total domestic product demand	
	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu	Million barrels	Trillion Btu
Fuel and power—Continued												
Jet fuels:												
Naphtha type	--	--	--	--	76.5	409.7	--	--	--	--	76.5	409.7
Kerosine type	--	--	--	--	285.6	1,619.4	3.2	18.1	--	--	288.8	1,637.5
Total	--	--	--	--	362.1	2,029.1	3.2	18.1	--	--	365.3	2,047.2
Gasoline	--	--	--	--	2,450.3	12,859.2	--	--	--	--	2,450.3	12,859.2
Kerosine	45.1	255.7	12.9	73.2	--	--	--	--	--	--	58.0	328.9
Distillate fuel	487.1	2,837.4	126.6	737.4	354.5	2,065.0	62.0	361.2	10.2	59.3	1,040.4	6,060.3
Residual fuel	155.1	975.1	162.8	1,023.5	116.3	731.2	454.9	2,860.0	6.2	39.0	895.3	5,628.8
Still gas	--	--	175.4	1,052.4	--	--	--	--	--	--	175.4	1,052.4
Petroleum coke	--	--	64.8	390.4	--	--	--	--	--	--	64.8	390.4
Total	854.4	4,738.4	610.2	3,548.5	3,310.9	17,795.6	520.1	3,239.3	16.4	98.3	5,312.0	29,420.1
Raw material: [4]												
Plant condensate	--	--	6.9	37.4	--	--	--	--	--	--	6.9	37.4
Special naphthas	--	--	27.5	144.3	--	--	--	--	--	--	27.5	144.3
Lubes [5] and waxes	--	--	33.7	201.1	22.6	137.1	--	--	--	--	56.3	338.2
Petroleum coke [6]	--	--	25.2	151.8	--	--	--	--	--	--	25.2	151.8
Asphalt and road oil	152.8	1,014.0	--	--	--	--	--	--	--	--	152.8	1,014.0
Petrochemical feedstock offtake:												
Liquefied refinery gas [7]	--	--	32.8	127.7	--	--	--	--	--	--	32.8	127.7
Liquefied petroleum gas [7,8]	--	--	191.1	654.8	--	--	--	--	--	--	191.1	654.8
Naphtha (−400°)	--	--	53.5	280.8	--	--	--	--	--	--	53.5	280.8
Still gas	--	--	15.7	94.2	--	--	--	--	--	--	15.7	94.2
Miscellaneous (+400°)	--	--	47.5	276.7	--	--	--	--	--	--	47.5	276.7
Total	152.8	1,014.0	433.9	1,968.8	22.6	137.1	--	--	--	--	609.3	3,119.9
Miscellaneous and unaccounted for	--	--	--	--	--	--	--	--	32.7	179.7	32.7	179.7
Grand total domestic product demand	1,007.2	5,752.4	1,044.1	5,517.3	3,333.5	17,932.7	520.1	3,239.3	49.1	278.0	5,954.0	32,719.7

p Preliminary.
[1] Includes liquefied refinery gas and natural gas liquids.
[2] Includes bunkers, military transportation, and all military use of distillate and residual fuel oils.
[3] Includes secondary recovery of petroleum and agriculture uses.
[4] Includes some fuel and power used by raw materials industries.
[5] Lubricants are distributed on basis of data from Bureau of the Census.
[6] Includes portions of petroleum coke estimated to be consumed in nonfuel uses.
[7] Includes ethane.
[8] Includes LPG for synthetic rubber.

Table 22.—Electrical energy sales to ultimate consumers

(Million kilowatt-hours)

Region	Total consumption	Residential	Industrial and commercial	Total consumption	Residential	Industrial and commercial
	1971			1972		
New England	59,072	22,870	34,645	63,782	24,614	37,509
Middle Atlantic	208,567	62,878	133,086	219,861	65,978	140,639
East North-Central	281,393	84,629	186,011	304,297	89,736	203,268
West North-Central	94,872	37,372	54,395	100,687	39,074	58,316
South Atlantic	234,920	87,559	137,798	252,811	93,563	149,062
East South-Central	142,057	45,905	93,823	153,430	48,404	102,441
West South-Central	164,047	51,497	105,361	181,902	57,952	116,218
Mountain	66,168	18,641	44,427	71,805	20,609	47,719
Pacific	209,980	65,814	133,615	223,309	69,441	142,551
Alaska and Hawaii	5,365	1,915	3,291	5,830	2,052	3,603
Total United States	1,466,441	479,080	926,452	1,577,714	511,423	1,001,326
	1973			1974		
New England	68,364	26,169	40,461	66,894	26,094	39,180
Middle Atlantic	235,310	70,729	153,006	229,430	68,820	149,177
East North-Central	331,776	96,164	223,580	328,968	96,949	219,985
West North-Central	108,912	42,146	63,212	109,670	42,339	63,725
South Atlantic	280,103	106,750	163,548	279,090	106,656	163,518
East South-Central	168,890	51,958	114,161	169,246	51,610	114,818
West South-Central	195,624	62,205	125,314	200,735	63,239	129,405
Mountain	77,181	23,375	50,294	81,670	24,464	53,536
Pacific	230,547	72,354	146,584	228,243	72,390	144,603
Alaska and Hawaii	6,496	2,321	3,978	6,823	2,399	4,204
Total United States	1,703,203	554,171	1,084,138	1,700,769	554,960	1,082,151

Source: Edison Electric Institute. Statistical Yearbook of the Electric Utility Industry, 1971–74, table 22S.

Table 23.—Total employment in selected mineral industries

(Thousands)

Industry	1971	1972	1973	1974	1975
MINING					
Metals:					
Iron ores	24.5	20.1	21.3	24.2	24.8
Copper ores	34.7	38.9	42.3	42.8	37.1
Total [1]	89.0	86.1	90.5	92.3	92.3
Nonmetal mining and quarrying	113.0	112.1	115.8	119.2	115.1
Fuels:					
Bituminous	132.3	143.2	158.0	165.0	198.2
Other coal	5.4	3.7	3.6	3.5	3.6
Crude petroleum and natural gas fields	141.0	137.8	133.5	143.7	159.5
Oil and gas field services	120.3	124.1	131.0	148.2	176.2
Total	399.0	408.8	426.1	460.4	537.5
Total mining [2]	601.0	607.0	[3] 625.0	[3] 672.0	745.0
MANUFACTURING					
Minerals:					
Fertilizers, complete and mixing only	38.2	35.8	38.5	37.3	33.7
Cement, hydraulic	32.0	33.6	33.8	32.7	30.3
Blast furnaces, steelworks, rolling mills	506.3	492.2	521.8	[3] 522.6	470.1
Nonferrous smelting and refining	83.9	83.6	86.3	90.7	82.2
Total	660.4	645.2	680.4	[3] 683.3	616.3
Fuels:					
Petroleum refining	153.1	150.8	147.3	154.6	154.2
Other petroleum and coal products	36.7	38.8	[3] 40.0	40.7	43.2
Total [4]	189.8	189.6	[3] 187.3	195.3	197.4
Total selected manufacturing	850.2	834.8	[3] 867.7	[3] 878.6	813.7

[1] Includes other metal mining not shown separately.
[2] Data may not add to totals shown because of independent rounding.
[3] Corrected figure.
[4] Standard Industrial Classification 295, paving and roofing materials, included in total.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Employment and Earnings, v. 18–22, March 1972–76, table B-2.

Table 24.—Average hours and gross earnings of production and related workers in the mineral and mineral fuels industries

	1971	1972	1973	1974	1975
MINING					
Metal:					
Iron ores:					
Weekly earnings	$169.70	$185.40	$198.56	$241.43	$271.35
Weekly hours	40.5	41.2	42.7	43.5	42.8
Hourly earnings	$4.19	$4.50	$4.65	$5.55	$6.34
Copper ores:					
Weekly earnings	$178.46	$192.19	$206.52	$226.46	$248.14
Weekly hours	42.9	41.6	42.3	41.1	39.2
Hourly earnings	$4.16	$4.62	$4.88	$5.51	$6.33
All metal mining:[1]					
Weekly earnings	$171.39	$185.51	$200.40	$226.97	$250.72
Weekly hours	41.6	41.5	42.1	41.8	40.9
Hourly earnings	$4.12	$4.47	$4.76	$5.43	$6.13
Nonmetallic mining and quarrying:					
Weekly earnings	$165.23	$176.96	$196.88	$209.28	$210.98
Weekly hours	44.9	44.8	47.1	46.3	43.5
Hourly earnings	$3.68	$3.95	$4.18	$4.52	$4.85
All mining (excluding fuels):[2]					
Weekly earnings	$167.89	$180.61	$195.90	$213.09	$228.55
Weekly hours	43.5	43.4	44.0	43.5	42.4
Hourly earnings	$3.87	$4.17	$4.47	$4.91	$5.42
Fuels:					
All coal mining:					
Weekly earnings	$194.00	$215.83	$226.86	$236.84	$283.35
Weekly hours	[3] 40.6	[3] 41.0	39.9	38.2	[3] 39.3
Hourly earnings	[3] $4.79	[3] $5.30	[3] $5.69	$6.20	[3] $7.21
Bituminous coal:					
Weekly earnings	$196.02	$217.46	$228.45	$238.37	$284.53
Weekly hours	[3] 40.6	[3] 41.0	39.8	38.2	[3] 39.2
Hourly earnings	[3] $4.85	[3] $5.34	$5.74	$6.24	[3] $7.23
Crude petroleum and natural gas:					
Weekly earnings	$159.75	$169.92	$191.82	$223.86	$248.84
Weekly hours	42.6	42.8	40.9	42.0	40.8
Hourly earnings	$3.75	$3.97	$4.69	$5.33	$6.05
All fuels:[2]					
Weekly earnings	$173.59	$191.27	$201.43	$224.08	$256.86
Weekly hours	41.8	41.8	40.8	41.9	42.2
Hourly earnings	$4.22	$4.53	$4.90	$5.39	$6.14
MANUFACTURING					
Fertilizers, complete and mixing only:					
Weekly earnings	$132.71	$143.14	$155.66	$172.40	$188.72
Weekly hours	42.4	42.6	43.0	43.1	42.6
Hourly earnings	$3.13	$3.36	$3.62	$4.00	$4.43
Cement, hydraulic:					
Weekly earnings	$194.37	$215.37	$233.20	$247.97	$262.06
Weekly hours	41.8	42.0	42.4	42.1	41.4
Hourly earnings	$4.65	$5.12	$5.50	$5.89	$6.33
Blast furnaces, steel and rolling mills:					
Weekly earnings	$181.43	$210.12	$230.74	$263.49	$278.71
Weekly hours	39.7	40.8	41.8	41.3	39.2
Hourly earnings	$4.57	$5.15	$5.56	$6.38	$7.11
Nonferrous smelting and refining:					
Weekly earnings	$166.83	$185.59	$203.46	$227.46	$243.76
Weekly hours	41.5	41.8	42.3	42.2	40.9
Hourly earnings	$4.02	$4.44	$4.81	$5.39	$5.96
Petroleum refining and related industries:					
Weekly earnings	$194.33	$208.89	$220.28	$238.71	$267.07
Weekly hours	42.4	42.2	42.2	42.4	41.6
Hourly earnings	$4.58	$4.95	$5.22	$5.63	$6.42
Petroleum refining:					
Weekly earnings	$202.44	$219.45	$231.02	$250.92	$283.87
Weekly hours	42.0	41.8	41.7	42.1	41.2
Hourly earnings	$4.82	$5.25	$5.54	$5.96	$6.89
Other petroleum and coal products:					
Weekly earnings	$166.44	$175.34	$187.91	$199.67	$215.28
Weekly hours	43.8	43.4	43.7	43.5	42.8
Hourly earnings	$3.80	$4.04	$4.30	$4.59	$5.03
All manufacturing:[2]					
Weekly earnings	$181.46	$206.52	$224.92	[4] $250.99	$268.58
Weekly hours	40.4	41.1	41.7	41.7	40.1
Hourly earnings	$4.49	$5.02	$5.41	[4] $6.03	$6.71

[1] Includes other metal mining not shown.
[2] Weighted average of data computed using figures for production workers as weights.
[3] 11-month average.
[4] Corrected figure.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Employment and Earnings, v. 18–22, March 1972–76, table C-2.

Table 25.—Wages, salaries, and average annual earnings in the United States

	1973	1974	1975	Percent change 1973–74	Percent change 1974–75
Wages and salaries:					
All industries, total ------- millions --	$701,214	$764,486	$806,663	+9.0	+5.5
Mining ---------------------- do ----	7,290	8,834	10,736	+21.2	+21.5
Manufacturing --------------- do ----	196,186	211,403	211,658	+7.8	+.1
Average earnings per full-time employee:					
All industries, total ----------------	9,290	10,004	10,892	+7.7	+8.9
Mining ------------------------------	11,683	12,896	14,647	+10.4	+13.6
Manufacturing -----------------------	10,027	10,845	11,941	+8.2	+10.1

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business. V. 56, No. 7, July 1976, p. 51, table 6.6; p. 52, table 6.9.

Table 26.—Average labor–turnover rates in selected mineral industries [1]
(Per thousand employees)

Rates and year	Manufacturing	Cement, hydraulic	Blast furnaces, steel and rolling mills	Nonferrous smelting and refining	Metal mining	Iron ores	Copper ores	Petroleum refining and related industries [2]	Petroleum refining	Coal mining
Total accession rate:										
1973 ----------	48	17	25	26	38	27	39	22	16	17
1974 ----------	42	15	20	27	35	26	32	23	17	19
1975 ----------	37	29	28	18	27	23	19	18	12	23
Total separation rate:										
1973 ----------	46	16	21	25	34	21	34	22	15	16
1974 ----------	48	22	23	26	31	21	31	24	15	13
1975 ----------	42	41	42	30	32	27	31	19	12	14
Layoff rate:										
1973 ----------	9	3	4	4	3	5	1	5	5	3
1974 ----------	15	10	7	4	3	4	3	7	4	2
1975 ----------	21	31	30	17	10	13	13	7	3	2

[1] Monthly rates are available in Employment and Earnings as indicated in source.
[2] Standard Industrial Classification 295, paving and roofing materials, included in total.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Employment and Earnings, v. 20–22, No. 9, March 1974–76, table D-2.

Table 27.—Labor productivity indexes for selected minerals [1]

(1967=100)

Year	Copper, crude ore mined per—			Iron, crude ore mined per—		
	Employee	Production worker	Production worker man-hour	Employee	Production worker	Production worker man-hour
1970	129.3	122.6	115.2	113.8	115.6	116.0
1971	126.7	125.3	121.2	110.8	112.8	117.1
1972	123.7	119.3	118.1	119.2	122.2	124.4
1973	126.8	121.0	117.7	127.3	129.0	126.7
1974 p	117.5	113.5	113.8	120.8	122.4	118.1
	Copper, recoverable metal mined per—			Iron, usable ore mined per—		
	Employee	Production worker	Production worker man-hour	Employee	Production worker	Production worker man-hour
1970	118.0	111.8	105.1	103.4	105.0	105.4
1971	109.7	108.4	104.9	97.5	99.3	103.0
1972	107.4	103.6	102.5	101.9	104.6	106.5
1973	104.6	99.7	97.0	108.7	110.1	108.2
1974 p	91.9	88.8	89.0	99.3	100.6	97.6
	Petroleum refined per—			Bituminous coal and lignite mined per—		
	Employee	Production worker	Production worker man-hour	Employee	Production worker	Production worker man-hour
1970	106.3	107.6	106.6	97.6	97.9	97.3
1971	110.2	112.1	112.3	87.3	91.9	91.7
1972	121.2	121.5	121.9	83.0	85.0	83.9
1973	131.4	133.0	135.7	81.4	82.5	83.3
1974 p	124.9	125.2	126.6	75.8	77.5	81.7

p Preliminary.
[1] Series revised to incorporate additional data from economic censuses.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Productivity Indexes for Selected Industries, 1975 edition, tables 2, 4, 6, 8, 12, 46.

Table 28.—Index of average unit mine value of minerals produced

(1967=100)

	1971	1972	1973	1974	1975 p
METALS					
Ferrous	115.9	120.2	125.5	159.5	207.3
Nonferrous:					
Base	129.9	130.7	151.1	205.7	181.5
Monetary	108.8	138.1	222.3	380.2	343.5
Other	130.0	131.2	136.7	150.1	213.4
Average	127.8	131.5	155.5	212.8	206.1
Average, all metals	121.5	125.5	139.6	184.6	206.8
NONMETALS					
Construction	112.7	120.8	127.2	147.2	170.6
Chemical	86.2	85.2	91.1	128.5	195.8
Other	115.7	123.4	132.5	148.7	172.2
Average	106.9	113.0	119.4	143.1	176.4
FUELS					
Coal	152.9	165.2	183.3	339.8	405.6
Crude oil and natural gas	115.6	116.4	133.8	221.6	263.9
Average	120.6	123.4	141.6	241.4	283.3
Average, all minerals	117.6	121.2	136.4	214.6	252.9

p Preliminary.

Table 29.—Index of implicit unit value of minerals produced

(1967=100)

	1971	1972	1973	1974	1975 p
METALS					
Ferrous	115.6	119.5	123.7	157.5	204.2
Nonferrous:					
Base	130.1	130.6	151.0	202.4	176.9
Monetary	107.9	136.2	212.2	369.4	356.5
Other	132.0	136.4	141.3	156.3	227.3
Average	128.7	131.4	153.3	205.8	192.5
Average, all metals	124.1	127.3	142.1	187.8	196.8
NONMETALS					
Construction	112.8	120.6	127.0	146.5	169.9
Chemical	86.9	84.6	90.2	126.6	198.7
Other	115.2	119.8	128.0	145.0	169.4
Average	107.3	112.5	119.2	141.8	177.1
FUELS					
Coal	152.9	165.5	183.5	340.2	405.5
Crude oil and natural gas	115.5	116.4	133.8	220.2	264.5
Average	119.8	129.2	141.5	240.8	286.3
Average, all minerals	117.6	121.2	136.4	211.5	252.5

p Preliminary.

Table 30.—Price indexes for selected metals, minerals, and fuels

(1967=100)

Commodity	Annual average 1974	Annual average 1975	Percent change from 1974
Metals and metal products	171.9	185.6	+8.0
Iron and steel	178.6	200.9	+12.5
Iron ore	123.3	154.3	+25.1
Iron and steel scrap	353.2	245.6	−30.5
Semifinished steel products	169.0	206.7	+22.3
Finished steel products	170.0	196.6	+15.6
Foundry and forge shop products	161.4	194.3	+20.4
Pig iron and ferroalloys	188.1	264.7	+40.7
Nonferrous metals	187.1	171.6	−8.3
Primary metal refinery shapes	197.7	321.4	+62.6
Aluminum ingot	151.3	160.4	+6.0
Lead, pig, common	159.1	154.0	−3.2
Zinc, slab, prime western	249.2	270.2	+8.4
Nonferrous scrap	197.5	128.3	−35.0
Nonmetallic mineral products	153.2	174.0	+13.6
Concrete ingredients	148.7	172.3	+15.9
Sand, gravel, crushed stone	135.2	151.1	+11.8
Structural clay products, excluding refractories	135.2	151.2	+11.8
Gypsum products	137.6	144.0	+4.7
Other nonmetallic minerals	188.7	220.3	+16.7
Building lime	152.6	186.0	+21.9
Insulation materials	156.5	196.2	+25.4
Bituminous paving materials	222.0	256.9	+15.7
Fertilizer materials	124.2	198.8	+60.1
Nitrogenates	126.9	178.6	+40.7
Phosphates	118.6	236.3	+99.2
Phosphate rock	184.2	428.9	+132.8
Potash	132.6	166.6	+25.6
Fuels and related products and power	208.3	245.1	+17.7
Coal	332.4	385.8	+16.1
Anthracite	247.3	372.7	+50.7
Bituminous	339.5	387.0	+14.0
Coke	247.7	330.8	+33.5
Gas fuels	162.2	216.7	+33.6
Electric power	163.1	193.4	+18.6
Petroleum products, refined	223.4	257.5	+15.3
Crude petroleum [1]	211.8	245.7	+16.0
All commodities other than farm and food	153.8	171.5	+11.5
All commodities	160.1	174.9	+9.2

[1] Includes only domestic production.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Wholesale Prices and Price Indexes. January–September, December 1975, table 6; January 1976, table 4; Supplement 1975, table 5.

Table 31.—Comparative mineral energy resource prices

Fuel	1973	1974	1975
Bituminous coal, average price at merchant coke ovens dollars per net ton	19.77	34.20	52.63
Anthracite, average sales realization per net ton at preparation plants, excluding dredge coal:			
Chestnut dollars	19.30	31.06	[e] 42.15
Pea do	16.98	27.61	[e] 39.50
Buckwheat, No. 1 do	16.61	28.36	[e] 38.40
Petroleum and petroleum products:			
Crude petroleum, average price per barrel at well do	3.89	6.74	8.00
Gasoline, average dealers' net price (excluding taxes) of gasoline in 55 U.S. cities [1] cents per gallon	19.48	30.53	35.78
Residual fuel oil: [1]			
No. 6 fuel, maximum 1% sulfur, average of high and low prices at Philadelphia [2] dollars per barrel	[3] 4.85	11.95	12.26
No. 6 fuel, maximum 0.3% sulfur, average of high and low prices at Philadelphia [2] do	5.68	13.11	13.16
Bunker C, average of high and low prices at all gulf ports do	3.42	[3] 10.28	9.30
Distillate fuel oil: [1]			
No. 2 distillate, average of high and low prices at Philadelphia cents per gallon	[3] 12.67	25.26	29.19
No. 2 distillate, average of high and low prices at all gulf ports do	[3] 21.74	[3] 30.69	28.43
Natural gas:			
Average U.S. value at well cents per thousand cubic feet	21.6	30.4	[e] 43.5
Average U.S. value at point of consumption do	66.5	88.8	[e] 115.0

[e] Estimate.
[1] Petroleum products from Platt's Oil Price Handbook.
[2] Prices at refineries and terminals in cargoes.
[3] Erroneously reported in previous year.

Table 32.—Cost of fuel in steam-electrical power generation
(Cents per million Btu)

Region	1972			1973			1974		
	Coal	Oil	Gas	Coal	Oil	Gas	Coal	Oil	Gas
New England	49.7	55.5	46.1	52.1	72.8	52.5	110.1	190.3	146.4
Middle Atlantic	42.1	62.3	53.1	47.4	80.0	62.4	81.2	200.1	114.1
East North-Central	38.9	68.0	51.6	42.9	78.4	58.2	65.4	170.0	76.8
West North-Central	34.0	69.9	29.9	36.9	81.6	34.6	44.1	139.0	41.8
South Atlantic	42.6	49.6	39.9	45.6	62.9	45.1	87.4	168.6	59.7
East South-Central	32.5	72.4	29.9	36.3	94.7	38.5	52.6	182.8	51.4
West South-Central	21.0	67.2	24.2	13.1	89.0	28.2	17.1	181.7	43.1
Mountain	22.7	58.2	35.1	25.1	95.9	39.1	28.7	164.0	50.8
Pacific	--	73.9	37.5	31.8	88.1	41.9	41.1	170.2	58.0
United States	38.2	58.8	30.3	41.4	75.9	34.1	66.2	181.1	48.3

Source: National Coal Association. Steam-Electric Plant Factors, 1973 through 1975, table 2.

Table 33.—Cost of electrical energy

(Cents per kilowatt-hour)

Region	1972			1973			1974		
	Total	Residential	Commercial and industrial	Total	Residential	Commercial and industrial	Total	Residential	Commercial and industrial
New England	2.5	2.9	2.2	2.6	3.1	2.3	3.6	4.2	3.3
Middle Atlantic	2.4	3.0	2.0	2.5	3.2	2.2	3.4	4.2	3.0
East North-Central	1.9	2.5	1.7	1.9	2.6	1.6	2.3	2.9	2.0
West North-Central	2.1	2.5	1.9	2.1	2.5	1.8	2.3	2.6	2.0
South Atlantic	1.8	2.1	1.5	1.9	2.2	1.6	2.4	2.7	2.2
East South-Central	1.2	1.6	1.0	1.3	1.7	1.1	1.5	1.9	1.3
West South-Central	1.5	2.2	1.2	1.6	2.2	1.3	1.8	2.4	1.5
Mountain	1.6	2.2	1.4	1.7	2.2	1.5	1.8	2.4	1.6
Pacific	1.4	1.8	1.2	1.5	1.9	1.3	1.8	2.3	1.7
Alaska and Hawaii	2.6	3.0	2.3	2.7	3.1	2.5	2.9	4.2	2.6
United States	1.8	2.3	1.5	1.9	2.4	1.6	2.3	2.8	2.0

Source: Edison Electric Institute. Statistical Yearbook of the Electric Utilities Industry, 1972 through 1974. Based on tables 22-S and 36-S.

Table 34.—Price index of principal metal mining expenses [1]

(1967=100)

Year	Total	Labor	Supplies	Fuel	Electrical energy
1971	119	123	116	114	114
1972	127	133	120	119	122
1973	136	142	128	146	129
1974	172	180	157	208	163
1975 p	196	205	177	245	193

p Preliminary.

[1] Indexes constructed using the following weights derived from the 1967 Census of Mineral Industries: Labor, 50.04; explosives, 3.18; steel mill shapes and forms, 7.32; all other supplies, 26.89; fuels, 5.88; electric energy, 6.69; and data from U.S. Department of Labor, Bureau of Labor Statistics, Wholesale Prices and Price Indexes. The index is computed for iron and copper ores only because sufficient data are not available for other mining sectors.

Table 35.—Index of major input expenses for bituminous coal and crude petroleum and natural gas mining [1]

(1967=100)

Year	Bituminous coal	Crude petroleum and natural gas
1971	129	114
1972	141	122
1973	155	136
1974	175	167
1975 p	222	NA

p Preliminary. NA Not available.

[1] Indexes constructed by using data from the U.S. Department of Labor, Bureau of Labor Statistics, Wholesale Prices and Price Indexes, annual and monthly, and weights derived from data shown in the 1967 Census of Mineral Industries, U.S. Department of Commerce, Bureau of the Census. Weights used are as follows: Bituminous coal—labor, 61.55; explosives, 2.70; steel mill shapes and forms, 5.08; all other supplies, 24.58; fuels, 1.74; electric energy, 4.35; crude petroleum and natural gas—labor, 44.65; supplies, 48.79; fuel, 2.07; and electric energy, 4.49.

Table 36.—Indexes of relative costs and productivity for iron ore, copper, bituminous coal, and petroleum mining [1]

(1967=100)

Year	Iron ore [2]	Copper [2]	Bituminous coal	Petroleum
INDEX OF LABOR COSTS PER UNIT OF OUTPUT				
1971	123	122	138	114
1972	128	138	154	127
1973	130	r 154	[3] 167	140
1974	172	190	181	171
1975 p	208	202	244	NA
INDEX OF VALUE OF PRODUCT PER MAN-PERIOD				
1971	109	141	144	132
1972	113	136	153	129
1973	r 121	r 150	169	143
1974	128	178	313	226
1975 p	152	160	321	NA
INDEX OF LABOR COSTS PER DOLLAR OF PRODUCT				
1971	117	90	90	99
1972	121	104	93	109
1973	116	r 100	90	105
1974	131	95	53	74
1975 p	126	121	60	NA

p Preliminary. r Revised. NA Not available.

[1] Index of labor costs per unit of output: Iron ore and copper indexes are computed from data found in U.S. Department of Labor, Employment and Earnings and Wholesale Price Indexes. Bituminous coal index based upon net tons per man per day (see chapter on Bituminous Coal) and index of average earnings derived from Bureau of Labor Statistics data on hourly earnings; petroleum index based on barrels per year (see chapter on Petroleum) and Bureau of Employment Security data on total wages in petroleum production.

Index of value of product per man-period: Iron ore and copper indexes are computed from data found in U.S. Department of Labor, Employment and Earnings and Wholesale Price Indexes. Bituminous coal index based on net tons per man per day and mine value of production; petroleum index based on average employment and total value of production.

Index of labor costs per dollar of product: Iron ore and copper indexes are computed from data found in U.S. Department of Labor, Employment and Earnings and Wholesale Price Indexes. Bituminous coal index based on index of value per man per day and index of average earnings; petroleum index based on total value of production and total wages.

[2] Indexes are for recoverable metal.

[3] Corrected figure.

Table 37.—Price indexes for selected items in minerals and mineral fuels production

(1967=100)

Commodity	1975 January	1975 December	Percent change from January	Annual average 1974	Annual average 1975	Percent change from 1974
Coal	428.8	371.2	−13.4	332.4	385.8	+16.1
Coke	330.4	331.1	+.2	247.7	330.8	+33.5
Gas fuels	181.0	245.6	+35.7	162.2	216.7	+33.6
Petroleum products, refined	242.3	274.7	+13.4	223.4	257.5	+15.3
Industrial chemicals	196.8	211.1	+7.3	151.7	206.9	+36.4
Lumber	176.5	200.2	+13.4	207.1	192.5	−7.0
Explosives	167.8	188.9	+12.6	146.6	178.0	+21.4
Construction machinery and equipment	177.3	192.5	+8.6	152.3	185.2	+21.6

Source: U.S. Department of Labor. Bureau of Labor Statistics. Wholesale Prices and Price Indexes. January and December 1975, table 6; January 1976, table 4; Supplement 1975, table 5.

Table 38.—Price indexes for mining construction and material handling machinery and equipment

(1967=100)

Year	Construction machinery and equipment	Mining machinery and equipment	Oilfield machinery and tools	Power cranes, excavators, equipment	Specialized construction machinery	Portable air compressors	Scrapers and graders	Mixers, pavers, spreaders, etc.	Tractors other than farm
1971	121.4	113.8	122.6	120.6	125.1	93.8	120.6	122.9	122.3
1972	125.7	117.2	127.3	126.0	129.0	92.0	124.4	126.3	127.3
1973	130.7	121.1	133.2	130.5	134.1	93.5	136.1	130.4	131.5
1974	152.3	143.6	157.8	152.2	151.3	102.8	160.4	145.1	154.7
1975	185.2	184.3	196.3	184.3	189.4	116.3	195.6	163.5	188.3

Source: U.S. Department of Labor, Bureau of Labor Statistics. Wholesale Prices and Price Indexes. Supplement 1972, 1973, 1974, 1975, table 5; January-December 1975, table 6.

Table 39.—National income originated in the mineral industries

Industry	Income, million dollars 1973	1974	1975	Percent change from 1974
Mining	10,149	15,406	18,804	+22.1
Metal mining	1,489	1,539	1,693	+10.0
Coal mining	2,869	5,189	6,732	+29.7
Crude petroleum and natural gas	3,908	6,602	8,180	+23.9
Mining and quarrying of nonmetallic minerals	1,883	2,076	2,119	+2.1
Manufacturing	283,540	298,150	309,941	+4.0
Chemicals and allied products	20,345	21,672	23,772	+9.7
Petroleum refining and related industries	8,535	14,053	13,778	−2.0
Stone, clay, glass products	9,750	9,680	9,451	−2.4
Primary metal industries	21,876	27,966	26,032	−6.9
All industries	1,072,829	1,152,002	1,236,175	+7.3

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 56, No. 7, July 1976, p. 50, table 6.3.

Table 40.—Annual average profit rates on shareholders' equity, after taxes, and total dividends, selected mineral manufacturing corporations

Industry	Annual profit rate, percent			Total dividends (million dollars)		
	1974 [1]	1975	Percent change from 1974	1974 [1]	1975	Percent change from 1974
All manufacturing	14.9	11.6	−22.1	19,456	19,995	+2.8
Primary metals	16.4	8.5	−48.2	1,216	1,172	−3.6
Primary iron and steel	16.8	10.7	−36.3	734	717	−2.3
Primary nonferrous metals	15.8	5.2	−67.1	483	454	−6.0
Stone, clay, glass products	10.6	6.8	−35.8	450	442	−1.8
Chemicals and allied products	18.3	15.2	−16.9	2,800	2,758	−1.5
Petroleum and coal products	21.0	12.5	−40.5	r 4,044	4,266	+5.5

r Revised.

[1] Numbers reflect a change in accounting methods from previous years; for further information see source.

Source: Federal Trade Commission. Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations. 4th Quarter, 1974, tables 4, A–D, and 4th Quarter, 1975, tables 4, A–D.

Table 41.—Industrial and commercial failures and liabilities in mining and manufacturing

Industry	1973	1974	1975
Mining:[1]			
Number of failures	32	9	26
Current liabilities thousands	$23,866	$10,102	$9,465
Manufacturing:			
Number of failures	1,431	1,548	1,619
Current liabilities thousands	$733,624	$823,722	$1,011,144
All industrial and commercial industries:			
Number of failures	9,345	9,915	11,432
Current liabilities thousands	$2,298,606	$3,053,137	$4,380,170

[1] Including fuels.

Source: Dun and Bradstreet, Inc., Business Economics Department. Monthly Failure Report, Y-16, No. 12, Feb. 18, 1975; K-17, No. 12, Mar. 5, 1976.

Table 42.—Expenditures for new plant and equipment by firms in mining and selected mineral manufacturing industries
(Billion dollars)

Industry	1973	1974	1975
Mining [1]	2.74	3.18	3.79
Manufacturing:			
Primary iron and steel	1.38	2.12	3.03
Primary nonferrous metals	1.67	2.33	2.28
Stone, clay, glass products	1.49	1.44	1.42
Chemical and allied products	4.46	5.69	6.25
Petroleum	5.45	8.00	10.51
All manufacturing	38.01	46.01	47.95

[1] Including fuels.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 55, No. 3, March 1975, p. 17, table 6; v. 56, No. 3, March 1976, p. 19, table 7.

Table 43.—Plant and equipment expenditures of foreign affiliates of U.S. companies by area and industry [1]
(Million dollars)

Area or country	1973 [r]			1974 [r]			1975		
	Mining and smelting	Petroleum	Manufacturing	Mining and smelting	Petroleum	Manufacturing	Mining and smelting	Petroleum	Manufacturing
Canada	554	1,002	1,814	424	1,245	2,669	620	1,180	2,207
Latin America	185	671	1,043	277	937	1,268	225	866	1,477
Europe	11	1,369	5,357	9	2,040	6,467	5	2,786	6,394
All other areas	351	3,532	1,033	369	4,263	1,326	334	4,538	1,306
Total	1,101	6,574	9,247	1,079	8,485	11,730	1,184	9,370	11,384

[r] Revised.
[1] Series revised back to 1966; see source for details.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 55, No. 9, September 1975, pp. 34-36.

Table 44.—Estimated gross proceeds from primary security offerings in 1975 [1]

Type of security	Total corporate		Manufacturing		Extractive [2]	
	Million dollars	Percent	Million dollars	Percent	Million dollars	Percent
Bonds	41,740	79.3	17,097	91.1	685	42.0
Preferred stock	3,458	6.6	537	2.9	75	4.6
Common stock	7,426	14.1	1,134	6.0	871	53.4
Total	52,624	100.0	[3] 18,767	100.0	1,631	100.0

[1] Substantially all new issues of securities offered for cash sale in the United States in amounts over $100,000 and with terms of maturity of more than 1 year are covered in these data.
[2] Including fuels.
[3] Data do not add to total shown because of independent rounding.

Source: U.S. Securities and Exchange Commission. Statistical Bulletin, v. 35, No. 4, April 1976, pp. 183, 186–189.

Table 45.—Direct private investment of U.S. companies in foreign petroleum industries in 1974 [p]

(Million dollars; net inflows to the United States designated by —)

Area or country	Petroleum				All industries			
	Book value beginning of year	Net capital outflows	Undistributed earnings of subsidiaries	Book value end of year	Book value beginning of year	Net capital outflows	Undistributed earnings of subsidiaries	Book value end of year
Developed countries [1]	15,911	1,292	1,180	18,352	72,214	5,042	5,523	82,792
Canada	5,320	−107	512	5,716	25,541	629	2,202	28,378
Europe	8,524	974	517	9,996	38,255	3,563	2,721	44,505
Japan	868	424	76	1,368	2,671	464	159	3,337
Australia, New Zealand, South Africa, Republic of	1,198	1	75	1,274	5,746	386	441	6,572
Developing countries [1]	8,436	−592	423	8,261	25,266	1,718	1,558	28,479
Latin American Republics and other Western Hemisphere	3,043	421	85	3,557	16,484	2,270	915	19,620
Other Africa	1,589	−416	174	1,340	2,376	−364	220	2,223
Middle East	2,139	−531	13	1,618	2,588	−487	25	2,129
Other Asia and Pacific	1,665	−65	152	1,746	3,818	299	398	4,507
International, unallocated	2,967	458	210	3,635	6,196	694	426	7,341
Total [1]	27,313	1,158	1,814	30,248	103,675	7,455	7,508	118,613

[p] Preliminary.
[1] Data may not add to totals shown because of independent rounding.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 55, No. 10, October 1975, p. 52, 53, tables 12, 13, p. 46, table 1, p. 55, table 15, p. 57, table 17.

Table 46.—Direct private investments of the United States in foreign mining and smelting industries in 1974 [p]
(Million dollars)

Area or country	Book value at yearend	Net capital outflows	Undistributed earnings of subsidiaries	Earnings [1]	Income [2]
Developed countries [3]	4,024	112	153	418	272
Canada	2,793	46	82	197	122
Europe	47	6	−2	−10	−8
Australia, New Zealand, South Africa, Republic of	1,184	60	74	232	158
Australia	960	51	66	194	129
South Africa, Republic of	(4)	8	8	37	28
Developing countries [3]	2,100	−148	32	376	363
Latin American Republics, total	1,037	−136	27	175	161
Mexico	84	−25	25	36	10
Panama	−1	−1	(5)	(5)	--
Brazil	84	7	−4	2	(4)
Chile	343	(4)	−1	−1	4
Peru	411	−5	2	45	51
Other Western Hemisphere	402	−86	(5)	96	102
Other Africa	442	(4)	(4)	(4)	(4)
Middle East	3	(5)	--	--	--
Other Asia and Pacific	216	(4)	(4)	(4)	(4)
Total [3]	6,124	−36	185	794	636

p Preliminary.
1 Earnings is the sum of the U.S. share in net earnings of subsidiaries and branch profits.
2 Income is the sum of dividends, interest, and branch profits.
3 Data may not add to totals shown because of independent rounding.
4 Combined in "other industries" in source reference.
5 Less than ½ unit.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 55, No. 10, October 1975, p. 46, table 1, p. 53, table 13, p. 55, table 15, p. 57, table 17, p. 59, table 19, p. 63, table 23.

Table 47.—Value of foreign direct investments in the United States
(Million dollars)

Industry	1970	1971	1972 [r]	1973	1974 [p]
Total	13,270	13,655	14,868	18,284	21,746
Petroleum	2,992	3,113	3,272	4,649	5,928

p Preliminary. r Revised.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business, v. 53, No. 2, February 1973, p. 30, v. 55, No. 10, October 1975, p. 37, table 1.

Table 48.—Railroad and water transportation of selected minerals and mineral energy products in the United States

(Thousand short tons)

Products	Rail[1] 1973	Rail[1] 1974	Rail[1] Percent change from 1973	Water[2] 1973	Water[2] 1974	Water[2] Percent change from 1973
Metals and minerals except fuels:						
Iron ore and concentrates	102,442	103,132	+0.7	83,979	79,893	−4.9
Iron and steel scrap	33,472	38,872	+16.1	1,826	2,311	+26.6
Pig iron	4,280	3,604	−15.8	281	256	−8.9
Iron and steel ingot, plates, rods, bars, tubing, other primary products	52,605	52,861	+.5	9,183	9,606	+4.6
Bauxite and other aluminum ores and concentrates	5,825	6,733	+15.6	313	583	+86.3
Other nonferrous ores and concentrates	15,654	15,171	−3.1	1,441	1,817	+26.1
Nonferrous metals and alloys	10,611	10,462	−1.4	652	679	+4.1
Nonferrous metal scrap	2,979	450	−84.9	72	87	+20.8
Slag	2,097	1,827	−12.9	937	1,400	+49.4
Sand and gravel	51,004	48,349	−5.2	81,774	76,444	−6.5
Stone, crushed and broken	59,757	59,289	−.8			
Limestone flux and calcareous stone	11,200	11,693	+4.4	36,497	36,316	−.5
Cement, building	20,835	17,681	−15.1	9,739	9,873	+1.4
Lime	6,610	6,874	+4.0	614	675	+9.9
Phosphate rock	39,146	41,909	+7.1	8,888	8,535	−4.0
Clays, ceramic and refractory materials	3,329	3,311	−.5	1,571	1,694	+7.8
Sulfur, dry	4,635	5,102	+10.1	42	37	−11.9
Sulfur, liquid				8,821	8,805	−.2
Gypsum and plaster rock	2,230	2,035	−8.7	1,102	709	−35.7
Other nonmetallic minerals except fuels	3,681	3,343	−9.2	6,271	7,052	+12.5
Fertilizer and fertilizer materials	19,529	19,633	+.5	5,950	6,121	+2.9
Total	451,921	452,331	+.1	259,953	252,893	−2.7
Mineral energy resources and related products:						
Coal:						
Anthracite	3,858	3,167	−17.9	144,522	144,779	+.2
Bituminous and lignite	372,220	387,704	+4.2			
Coke	21,857	23,546	+7.7	1,847	2,412	+30.6
Crude petroleum	1,722	2,374	+37.9	90,519	83,580	−7.7
Gasoline	1,340	1,263	−5.7	94,069	90,245	−4.1
Jet fuel				12,715	10,432	−18.0
Kerosine	96	86	−10.4	5,428	4,780	−11.9
Distillate fuel oil	1,306	1,101	−15.7	84,636	83,573	−1.3
Residual fuel oil	7,031	7,097	+.9	108,893	111,468	+2.4
Asphalt, tar, pitches	3,146	2,988	−5.0	9,206	8,950	−2.8
Liquefied petroleum gases and coal gases	7,212	6,979	−3.2	1,550	1,135	−26.8
Other petroleum and coal products[3]	24,006	25,248	+5.2	14,189	13,285	−6.4
Total	443,794	461,553	+4.0	567,574	554,639	−2.3
Total mineral products	895,715	913,884	+2.0	827,527	807,532	−2.4
Grand total, all commodities	1,532,165	1,530,686	−.1	994,158	982,700	−1.2
Mineral products, percent of grand total:						
Metals and minerals except fuels	29.5	29.6	+.3	26.1	25.7	−1.5
Mineral energy resources and related products	29.0	30.2	+4.1	57.1	56.4	−1.2
Total mineral products[4]	58.5	59.7	+2.1	83.2	82.2	−1.2

[1] Revenue freight originated on respondent's road and terminated on line by originating carrier or delivered to connecting rail carrier.
[2] Domestic traffic includes all commercial movement between points in the United States, Puerto Rico, and the Virgin Islands.
[3] Includes lubricants, naphtha, and other petroleum solvents, and miscellaneous coal and petroleum products.
[4] Data may not add to totals because of independent rounding.

Source: Interstate Commerce Commission, Bureau of Accounts. Freight Commodity Statistics. Class I Railroads in the United States, Dec. 31, 1973 and 1974. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 5. National Summaries, Calendar years 1973 and 1974, table 2.

Table 49.—Percentage distribution of mine shipments of bituminous coal and lignite by method of shipment and mine use

Year	Shipped by rail and trucked to rail	Shipped by water and trucked to water	Trucked to final destination	Used at mines [1]	Total production
1971	69.2	10.7	10.9	9.2	100.0
1972	66.2	11.7	11.0	11.1	100.0
1973	67.1	11.5	9.8	11.6	100.0
1974	[2] 77.1	(2)	11.0	11.9	100.0
1975	64.5	10.7	12.2	12.6	100.0

[1] Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for all other purposes at mine, and transported from mine to point of use by conveyor, tram, or pipeline.
[2] Bituminous coal and lignite shipped by water included with that shipped by rail.

Table 50.—Miles of utility gas main, by type of main [1]
(Thousands)

Type of main	1970	1971	1972	1973	1974
Field and gathering	66.6	66.5	67.1	[2] 66.2	67.0
Transmission	252.6	r 254.8	r 258.5	r 263.6	263.5
Distribution	595.6	610.7	624.6	r 634.6	646.2
Total	914.8	r 932.0	r 950.2	r 964.4	976.7

r Revised.
[1] Excludes service pipe. Data not adjusted to common diameter equivalent. Mileage shown as of end of each year.
[2] Corrected figure.

Source: American Gas Association. Gas Facts, a Statistical Record of the Gas Utility Industry in 1974, p. 49, table 42.

Table 51.—Petroleum pipelines selected years
(Miles)

Year	Trunklines		Gathering lines	Total
	Crude	Products		
1962	70,355	53,200	76,988	200,543
1965	72,383	61,443	77,041	210,867
1968	70,825	64,529	74,124	209,478
1971	75,143	72,396	71,132	218,671
1974	76,250	76,839	69,266	222,355

Table 52.—Research and development activity
(Million dollars)

Industry	Funds expended								
	Total [1]			Company			Federal Government		
	1972	1973	1974	1972	1973	1974	1972	1973	1974
Petroleum refining and extraction	r 468	504	598	r 454	490	578	15	14	20
Percent of all industries	2.4	2.4	2.7	4.0	3.9	4.1	0.2	0.2	0.2
Chemicals and allied products	r 1,896	r 2,081	2,364	r 1,705	r 1,875	2,148	r 190	r 206	216
Percent of all industries	9.8	9.9	10.6	15.1	14.8	15.3	2.4	2.5	2.6
All industries	r 19,383	r 20,921	22,348	r 11,326	r 12,699	14,018	r 8,057	r 8,222	8,329

r Revised.
[1] Data may not add to totals shown because of independent rounding.

Source: National Science Foundation, Research and Development in Industry, 1975. NSF 75-315, table B-2. Science Resources Studies Highlights. NSF 76-300, Jan. 14, 1976, p. 2.

Table 53.—Federal obligated funds for metallurgy and materials research
(Thousand dollars)

Federal agency	Fiscal year 1975 Basic research	Fiscal year 1975 Applied research	Fiscal year 1975 Total research	Fiscal year 1976 e Basic research	Fiscal year 1976 e Applied research	Fiscal year 1976 e Total research
Department of Defense	36,645	71,507	108,152	33,053	80,738	113,791
Energy Research and Development Administration	14,658	13,386	28,044	16,250	14,347	30,597
National Aeronautic and Space Administration	7,250	69,696	76,946	7,729	70,660	78,389
Bureau of Mines	750	31,595	32,345	200	36,069	36,269
National Science Foundation	15,288	3,880	19,168	16,310	4,250	20,560
Department of Commerce	1,059	921	1,980	1,124	1,001	2,125
Other	7	977	984	5	1,096	1,101
Total	75,657	191,962	267,619	74,671	208,161	282,832

e Estimate.

Source: National Science Foundation. Federal Funds for Research Development and Other Scientific Activities, Fiscal Years 1974, 1975, and 1976, v. 24, Detailed Statistical Tables, Appendices C and D. NSF 75-323, September, 1974, tables C-24, C-25, C-43, C-44, C-62, C-63.

Table 54.—Bureau of Mines obligations for mining and mineral research and development
(Thousand dollars)

Fiscal year	Applied research	Basic research	Development	Total
1972	32,805	7,846	30,237	70,888
1973	34,591	6,863	36,053	77,507
1974	24,880	5,637	35,590	66,107
1975	50,977	1,935	48,717	101,629
1976 e 1	79,000	900	59,070	138,970

e Estimate.
[1] Does not include transition quarter.

Table 55.—Bureau of Mines obligations for total research, by field of science
(Thousand dollars)

Field	Fiscal year 1974	Fiscal year 1975	Fiscal year 1976 e 1
Engineering sciences	23,909	47,712	73,885
Physical sciences	5,294	1,885	2,065
Mathematical sciences	477	1,285	1,580
Environmental sciences	837	2,030	2,370
Total	30,517	52,912	79,900

e Estimate.
[1] Does not include transition quarter.

Table 56.—Summary of Government inventories of strategic and critical materials December 31, 1975

	Acquisition cost	Market value [1]
Total inventories in storage:		
National stockpile	$2,554,757,000	$5,258,909,800
Supplemental stockpile	1,095,071,000	1,947,922,700
Defense Production Act	310,408,900	225,886,700
Total on hand	3,960,236,900	7,432,719,200
Total inventories within objective (in storage)	524,678,200	1,112,436,500
Total excess inventories in storage	3,435,558,700	6,320,282,700

[1] Market values are computed from prices at which similar materials are being traded; or in the absence of current trading, at an estimate of the price which would prevail in commercial markets. Prices used are unadjusted for normal premiums and discounts relating to contained qualities, or for inherent materials-handling allowances. Market values do not necessarily reflect the amount that would be realized at time of sale. The uncommitted excess excludes the unshipped sales; the inventories in storage include quantities that have been sold but not shipped.

Source: General Services Administration, Federal Preparedness Agency. Stockpile Report to the Congress, July-December 1975, p. 2.

Table 57.—U.S Government stockpile disposal of mineral commodities, 1975

Commodity	Sales commitments: Quantity	Sales commitments: Sales values
NATIONAL AND SUPPLEMENTAL STOCKPILE INVENTORIES		
Aluminum ---- short tons	10,967	$8,796,427
Aluminum oxide, fused, crude ---- do	1,000	165,000
Asbestos, amosite ---- do	3,898	1,356,595
Cadmium ---- pounds	[1] —9,959	[1] —31,901
Cobalt ---- do	4,821,823	17,301,885
Columbium ores and concentrates ---- do	[1] —89,687	167,614
Diamond, industrial, bort ---- carats	2,329,384	4,953,536
Diamond, industrial, stones ---- do	1,069,757	12,341,515
Lead ---- short tons	[1] —3,929	[1] —1,567,671
Manganese, battery-grade, natural ore ---- short dry tons	43,694	2,857,140
Manganese, battery-grade, synthetic dioxide ---- do	50	22,500
Manganese, metallurgical ---- do	382,178	18,643,418
Manganese ore, chemical-grade, type B ---- do	18,000	1,177,680
Mica, muscovite block ---- pounds	501,035	702,461
Mica, muscovite film ---- do	21,482	74,091
Mica, muscovite splittings ---- do	4,825,213	1,588,546
Mica, phlogopite block ---- do	1,200	1,300
Mica, phlogopite splittings ---- do	79,200	57,175
Molybdenum disulfide ---- do	1,762,800	4,495,569
Molybdenum, ferro ---- do	291,048	910,012
Molybdic oxide ---- do	--	[2] 30,124
Quartz crystals ---- do	200,004	1,024,313
Rare earths ---- short dry tons	1,050	911,636
Silicon carbide, crude ---- short tons	37,787	10,867,498
Talc, steatite, block, and lump ---- do	1	283
Thorium nitrate ---- pounds	1,400	3,150
Tin ---- long tons	585	4,276,914
Tungsten ores and concentrates ---- pounds	3,569,090	18,431,076
Zinc ---- short tons	[1] —2,357	[1] —1,693,855
Total	--	107,864,031
DEFENSE PRODUCTION ACT (DPA) INVENTORY		
Aluminum ---- short tons	1,417	1,144,550
Columbium ores and concentrates ---- pounds	14,680	33,000
Manganese, metallurgical ---- short dry tons	91,639	1,728,433
Mica, muscovite block ---- pounds	1,199,485	1,544,539
Mica, muscovite film ---- do	3,414	15,678
Tantalum minerals ---- do	64,653	1,031,469
Titanium ---- short tons	746	1,819,174
Tungsten ores and concentrates ---- pounds	565,467	3,070,782
Total	--	10,387,625
OTHER		
Gold ---- troy ounces	1,254,472	[3] 154,553,505
Lithium ---- pounds	741,500	711,112
Mercury ---- flasks	501	112,242
Total	--	155,376,859
Grand total	--	273,628,515

[1] Negative figure represents adjustment of sales contract in previous report period.
[2] Figure represents price adjustments to prior contract.
[3] Represents that portion of the total proceeds of Treasury gold in excess of the U.S. monetary value based on $42.2222 per ounce. 1,254,472 ounces of gold were sold at an average price of $165.42.

Source: General Services Administration, Federal Preparedness Agency. Stockpile Report to the Congress, January-June 1975, pp. 14–15 and July-December 1975, pp. 14–15.

Table 58.—United Nations' indexes of world[1] mineral industry production

(1970=100)

Industry sector and geographic area	1973	1974	1975	1975 by quarter: 1st	2d	3d	4th
EXTRACTIVE INDUSTRIES							
Metals:							
Market economy countries	104	105	102	104	104	99	101
Developed[2]	100	99	96	96	100	93	94
United States and Canada	103	102	96	94	101	94	95
Europe	104	105	100	109	105	89	98
European Economic Community[3]	90	83	83	93	86	73	88
European Free Trade Association[4]	112	117	102	110	105	91	108
Australia and New Zealand	102	102	107	101	108	109	109
Developing[5]	110	115	112	117	111	109	111
Latin America[6]	109	119	115	129	112	110	100
Asia[7]	103	105	107	105	103	106	112
Centrally planned economy countries (Europe)[8]	118	121	121	121	121	121	120
World	107	109	106	108	108	104	105
Coal:							
Market economy countries	88	85	88	92	89	79	90
Developed[2]	87	83	84	89	86	76	87
United States and Canada	102	102	112	112	116	105	114
Europe	83	76	76	82	77	67	78
European Economic Community[3]	81	74	73	80	74	63	75
European Free Trade Association[4]	96	97	90	92	94	81	92
Australia and New Zealand	116	133	128	128	137	107	140
Developing[5]	106	114	126	129	121	121	131
Latin America[6]	111	125	132	NA	NA	NA	NA
Asia[7]	104	112	125	131	121	121	126
Centrally planned economy countries (Europe)[8]	107	110	103	112	114	112	114
World	96	96	98	100	100	94	100
Crude petroleum and natural gas:							
Market economy countries	121	121	114	112	110	117	116
Developed[2]	112	112	108	112	106	104	112
United States and Canada	104	102	98	100	97	98	99
Europe	159	166	169	196	153	127	199
European Economic Community[3]	166	175	177	208	160	130	212
European Free Trade Association[4]	NA	NA	NA	NA	NA	NA	NA
Australia and New Zealand[9]	--	--	--	--	--	--	--
Developing[5]	127	127	117	113	112	126	118
Latin America[6]	102	99	100	100	97	98	99
Asia[7]	149	150	136	134	131	144	133
Centrally planned economy countries (Europe)[8]	122	130	140	141	140	142	136
World	121	123	119	119	116	122	120
Total extractive industry:							
Market economy countries	112	112	107	107	106	107	108
Developed[2]	104	103	100	102	101	96	102
United States and Canada	105	104	100	100	100	98	100
Europe	100	98	97	103	98	85	100
European Economic Community[3]	100	98	97	103	98	85	100
European Free Trade Association[4]	110	112	107	111	112	102	102
Australia and New Zealand	136	144	146	142	148	141	151
Developing[5]	123	126	118	115	113	123	118
Latin America[6]	105	109	108	111	105	109	106
Asia[7]	145	148	134	132	130	141	132
Centrally planned economy countries (Europe)[8]	118	124	131	131	132	131	129
World	114	116	114	114	114	114	114
PROCESSING INDUSTRIES							
Base metals:							
Market economy countries	117	119	104	110	105	97	103
Developed[2]	117	118	100	107	102	93	98
United States and Canada	117	116	92	102	94	85	89
Europe	112	117	102	110	105	91	108
European Economic Community[3]	109	102	97	104	98	86	98
European Free Trade Association[4]	113	116	100	111	104	88	98
Australia and New Zealand	107	111	107	112	103	108	103
Developing[5]	121	137	146	137	148	148	151
Latin America[6]	128	145	153	142	159	152	158
Asia[7]	105	121	136	127	124	146	146
Centrally planned economy countries (Europe)[8]	128	145	153	142	159	152	158
World	118	121	114	117	114	110	117

See footnotes at end of table.

Table 58.—United Nations' indexes of world[1] mineral industry production—Continued

(1970=100)

Industry sector and geographic area	1973	1974	1975	1975 by quarter			
				1st	2d	3d	4th
PROCESSING INDUSTRIES—Continued							
Nonmetallic mineral products:							
Market economy countries	122	121	113	107	115	114	116
Developed[2]	121	118	108	102	110	108	111
United States and Canada	123	119	105	97	104	110	108
Europe	118	118	112	108	117	108	114
European Economic Community[3]	116	115	109	105	113	105	113
European Free Trade Association[4]	117	118	100	103	108	92	98
Australia and New Zealand	122	116	114	99	117	120	120
Developing[5]	131	140	150	140	152	153	154
Latin America[6]	135	144	152	142	153	156	158
Asia[7]	125	137	148	135	152	154	151
Centrally planned economy countries (Europe)[8]	125	134	143	142	145	144	142
World	124	126	125	121	127	126	126
Chemicals, petroleum and coal products:							
Market economy countries	127	130	124	119	122	123	130
Developed[2]	127	130	121	117	120	120	128
United States and Canada	126	128	120	112	117	123	127
Europe	126	131	124	125	125	116	131
European Economic Community[3]	125	125	129	121	121	113	128
European Free Trade Association[4]	123	129	111	120	120	106	123
Australia and New Zealand	127	126	113	107	114	115	117
Developing[5]	127	134	139	131	136	141	147
Latin America[6]	134	145	151	NA	NA	NA	NA
Asia[7]	117	115	117	113	110	122	125
Centrally planned economy countries (Europe)[8]	134	149	167	167	169	167	164
World	128	135	134	130	133	133	138
OVERALL INDUSTRIAL PRODUCTION							
Market economy countries	120	121	114	112	114	112	120
Developed[2]	119	119	111	109	111	108	116
United States and Canada	120	120	109	105	108	109	112
Europe	116	118	114	114	115	104	121
European Economic Community[3]	114	115	111	111	112	102	118
European Free Trade Association[4]	115	119	111	112	113	98	120
Australia and New Zealand	115	111	110	104	108	112	114
Developing[5]	128	137	146	141	142	147	153
Latin America[6]	131	141	146	NA	NA	NA	NA
Asia[7]	123	130	146	153	133	146	152
Centrally planned economy countries (Europe)[8]	129	142	155	153	156	156	156
World	122	127	126	108	108	104	105

NA Not available.
[1] Excludes Albania, the People's Republic of China, Mongolia, North Korea, and North Vietnam.
[2] Canada, the United States, all countries of Europe except those listed in footnotes 1 and 8, the Republic of South Africa, Israel, Japan, Australia, and New Zealand.
[3] Belgium, Denmark, France, West Germany, Ireland, Italy, Luxembourg, the Netherlands, and the United Kingdom.
[4] Austria, Norway, Portugal, Sweden, and Switzerland.
[5] Countries not indicated in footnotes 1, 2, and 8.
[6] Corresponds to the United Nations classifications "Caribbean, Central and South America."
[7] Corresponds to the United Nations classifications "Asia, excluding Israel and Japan."
[8] Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and the U.S.S.R.
[9] Reported as zero in source but both Australia and New Zealand produce natural gas; insufficient data available to calculate index number.

Source: United Nations. Monthly Bulletin of Statistics, August 1976, pp. xii–xxv.

Table 59.—Comparisons of world production and U.S. production and imports of principal minerals and mineral fuels in 1975

Mineral	World production (thousand short tons— unless otherwise stated) p	U.S. production (percent of world production)	U.S. imports (percent of world production)	Total 1975 U.S. production and imports (percent of world production)	Total 1974 U.S. production and imports (percent of world production)
METALLIC ORES AND CONCENTRATES					
Bauxite ------ thousand long tons --	73,939	2.4	[1] 14.6	17.0	21.1
Chromite ----------------------------	8,741	--	14.3	14.3	13.5
Copper (content of ore and concentrate) ----------------------	7,674	18.4	1.5	19.9	23.4
Iron ore ----- thousand long tons --	880,364	9.0	5.3	14.3	14.7
Lead (content of ore and concentrate) ----------------------	3,788	16.4	1.2	17.6	18.9
Mercury - thousand 76-pound flasks --	251	2.8	17.5	20.3	20.7
Molybdenum (content of ore and concentrate) - thousand pounds --	178,883	59.2	1.4	60.6	59.2
Nickel (content of ore and concentrate) ----------------------	900	1.9	17.9	19.8	27.4
Platinum-group (Pt, Pd, etc.) thousand troy ounces --	5,767	.3	31.6	31.9	56.5
Silver ---------------------- do ----	294,268	11.9	30.7	42.6	56.6
Titanium concentrates:					
Ilmenite (excluding slag)[2] ------	2,854	25.1	4.3	29.4	26.6
Rutile ----------------------------	[3] 387	W	57.9	W	[2] 66.3
Tungsten (content of ore and concentrate) - thousand pounds --	82,580	6.8	8.0	14.8	22.5
Zinc (content of ore and concentrate)	6,131	7.6	7.0	14.6	10.1
METALS, SMELTER BASIS					
Aluminum ----------------------------	13,273	29.2	4.1	33.3	38.0
Copper ------------------------------	7,780	18.5	1.9	20.4	22.9
Iron, pig ----------------------------	526,017	15.2	.1	15.3	17.0
Lead --------------------------------	3,714	14.3	2.7	17.0	18.4
Magnesium ----------------------------	142	W	W	W	W
Steel, raw ----------------------------	712,588	16.4	1.8	18.2	20.8
Tin -------- thousand metric tons --	230	2.8	19.1	21.9	20.1
Uranium oxide[2] ------ short tons --	26,442	43.9	4.6	48.5	54.4
Zinc --------------------------------	5,557	5.5	6.8	12.3	14.8
NONMETALS					
Asbestos ----------------------------	4,509	2.2	12.0	14.2	19.2
Cement ------------------------------	766,347	8.9	.5	9.4	11.2
Diamond -------- thousand carats --	41,126	--	45.9	45.9	51.5
Feldspar, crude ----------------------	3,041	22.0	6.9	28.9	24.0
Fluorspar, marketable ----------------	5,114	2.7	20.6	23.3	29.6
Gypsum ------------------------------	60,305	16.2	9.0	25.2	30.1
Mica (including scrap) thousand pounds --	515,616	52.3	2.1	54.4	100.0
Nitrogen, agricultural[4] ------------	46,505	29.2	2.8	32.0	32.0
Phosphate rock ----------------------	118,586	41.2	([5])	41.2	37.5
Potash (K_2O equivalent) ----------	27,423	9.1	13.6	22.7	26.1
Salt --------------------------------	179,109	23.3	1.8	25.1	27.3
Sulfur ------- thousand long tons --	49,164	22.9	3.9	26.8	27.5
MINERAL ENERGY RESOURCES					
Crude petroleum - thousand barrels --	19,497,213	15.7	7.7	23.4	21.8
Natural gas, marketed million cubic feet --	47,207,325	42.6	2.0	44.6	47.8
Bituminous coal and lignite --------	2,924,469	22.2	([5])	22.2	18.5
Anthracite --------------------------	195,195	3.2	--	3.2	3.4

p Preliminary. W Withheld to avoid disclosing individual company confidential data.
[1] Excludes imports into U.S. Virgin Islands.
[2] World total exclusive of the U.S.S.R. and the Republic of Korea.
[3] World total exclusive of the United States, the U.S.S.R., and the Republic of Korea.
[4] Year ended June 30, 1975.
[5] Less than ½ unit.

Table 60.—Value of world export trade in major mineral commodity groups [1]
(Million U.S. dollars)

Commodity group [1]	1970	1971	1972	1973	1974 p
Metals:					
All ores, concentrates, scrap	8,110	7,120	7,730	11,170	15,630
Iron and steel	17,070	17,760	20,080	28,480	46,440
Nonferrous metals	12,200	10,410	11,700	17,220	25,180
Subtotal	37,380	35,290	39,510	56,870	87,250
Nonmetals (crude only)	2,380	2,820	3,190	4,030	5,770
Mineral fuels	r 28,440	r 36,180	r 44,020	65,060	170,120
Total	r 68,200	r 74,290	r 86,720	125,960	263,140
All commodities	r 312,260	r 348,850	r 415,280	575,640	835,490

p Preliminary. r Revised.

[1] Data presented are for selected major commodity groups of the Standard International Trade Classification—Revised (SITC–R), and as such exclude some mineral commodities classified in that data array together with other (nonmineral) commodities. SITC–R categories included are as follows: Ores, concentrates, and scrap—SITC Division 28; iron and steel—SITC Division 67; nonferrous metals—SITC Division 68; nonmetals (crude only)—SITC Division 27; mineral fuels—SITC Division 3. Major items not included are the metals, metalloids, and metal oxides of SITC Group 513; mineral tar and crude chemicals from coal, petroleum, and natural gas of SITC Division 52; manufactured fertilizers of SITC Division 56; and nonmetallic mineral manufactures of SITC Groups 661, 662, 663, and 667.

Source: United Nations. Monthly Bulletin of Statistics, v. 30, No. 8, August 1976, pp. xxvii–xlv.

Table 61.—Mineral commodity export price indexes
(1970=100)

Year and quarter	Metal ores	Fuels	All crude minerals
1973	130	189	173
1974	175	577	473
1975:			
First quarter	200	586	488
Second quarter	199	583	486
Third quarter	199	577	482
Fourth quarter	199	628	519
Annual average	200	588	494

Source: United Nations. Monthly Bulletin of Statistics. V. 30, No. 9, September 1976, pp. xxi-xxii.

Table 62.—Analysis of export price indexes
(1970=100)

Year and quarter	Developed areas		Developing areas	
	Total minerals	Nonferrous base metals	Total minerals	Nonferrous base metals
1973	150	119	182	127
1974	274	149	555	160
1975:				
First quarter	309	129	559	114
Second quarter	302	126	560	110
Third quarter	293	123	557	108
Fourth quarter	301	123	607	103
Annual average	301	125	571	109

Source: United Nations. Monthly Bulletin of Statistics. V. 30, No. 9, September 1976, pp. xxi-xxii.

Mining and Quarrying Trends in the Metal and Nonmetal Industries

By John L. Morning [1]

MINING TRENDS

Although faced with a slowdown in the world economy, continued inflation, and rising costs, the mining industry exceeded its 1974 raw mineral production value of $55.1 billion by 13%. The increase was due to value increases in the production of fuels and nonmetals; metals reported a decrease in value. Of 23 metals produced, 14 showed value increases; of 44 nonmetals produced, 26 reported value increases.

Because of increasing costs and depletion of high-grade reserves, the mining industry continued to rely on new technologies to maintain its profit margins. In the surface mining sector, the development of new tools and equipment played a large part in increasing production and maintaining this goal. Some of the types of equipment developed were instrumentation for control of pit slope stability, shovel power transmissions, electric wheel trucks, and single-flight conveyor systems.

Equipment developed for control of pit slope stability was in the form of survey instrumentation which included optical-scale theodolites and optical-micrometer theodolites, the former capable of direct readings to 1 minute of arc and the latter capable of direct readings to 1 second. Through the use of these instruments, a complete picture of pit crest movement plus information on areas of potential slope failure is obtained.

The design and development of 12- to 25-cubic yard electric shovels for hardrock surface mining came about through the latest advances in solid state electronics. This totally static solid state electronic system permits the conversion of alternating current to direct current without the use of rotating machinery. By this means, torque overloads are eliminated, reducing the mechanical maintenance required. This enables electric shovel availability to remain at its customary 90% to 95%, regardless of the increase in size of equipment.

The 350-ton off-the-highway truck, the latest development toward larger earth-moving equipment, went into operation early in the year. Powered by a 3,300-horsepower diesel engine, the unit has four electric traction motors mounted within the rear wheels. Fully loaded, the total weight is over 600 tons. This unit is thought to be the ultimate limit for truck size, owing mainly to tire capacity and the adverse effect on pit haulage roads.

Replacing truck haulage by other haulage means, whether by conveyors or pipelines, is a problem faced by every open pit operation because truck haulage represents one-half of the total mining cost. Conveyors are generally favored owing to simplicity of operation and maintenance. To date the need to use numerous individual conveyors to carry material long distances has limited their application; however, the development of a single-flight conveyor system for use at unlimited distances may provide the needed breakthrough. The unlimited distance is obtained by the use of numerous intermediate drive

[1] Supervisory physical scientist, Division of Ferrous Metals.

modules. Each module consists of a primary driving mechanism driving rubber tires positioned above and between the top and bottom strands of belting. The developers claim that this method will eliminate to a great degree the need for multiflight conveyors and costly transfer points.

Problems faced by the underground mining industry were the same as those of the surface mining industry—increasing costs, inflation, labor problems, environmental constraints, etc. To retain economic stability, the industry developed new haulage methods, new roof control techniques, and new blasting techniques.

Underground haulage is rapidly changing from the track to the trackless system. Surveys indicated that 75% of all noncoal underground haulage in 1975 was trackless, and load-haul-dump (LHD) units predominated. The change to diesel-powered LHD units permits greater flexibility, higher productivity, and lower maintenance cost. Trends now indicate that the next change will be to larger units in the near future.

Because of increasing depth and extraction rates, roof control problems are also increasing. The switch from standard roof bolts to fully grouted bolts, although at present very gradual, indicates this to become the practice of the future. Bonding by grouting prevents not only anchor slip but also rock spalling at the hole collar. Grouts in use at present are resin and cement; cement is by far the cheaper. Further, remote bolting, as demonstrated by the Bureau of Mines' Inherently Safe Mine Systems Demonstrations, at the Jenny mine in Prestonburg, Ky., and the Peabody No. 10 mine near Springfield, Ill., is feasible, and remote grouting is a certainty in the future.

The drill-blast-load cycle in mining has been under study for some time. Most recently, changes in the blasting phase have been predominant. The quantity of high explosives used in the minerals industry has been decreasing for a number of years, and use of ammonium nitrate-fuel oil (AN-FO) products and water gels has been increasing. The reasons are twofold: (1) Safer handling and (2) ease of handling. The new explosives generate a substantially reduced amount of noxious gases and are extremely low in sensitivity. Also, these explosives can be loaded more easily and quickly than the standard dynamite.

Magnitude of the Mining Industry.—The number of metal and nonmetal mines increased from 14,775 in 1966 to 15,014 in 1975, primarily because of increases in sand and gravel and crushed and broken stone operations. However, the number of metal mines decreased from 1,631 to 609, and nonmetal mines, excluding sand and gravel and stone operations, decreased from 1,914 to 1,814 for the same years.

In the past decade, many small metal mines have become inactive, while mines with over 10 million tons of crude ore output per year increased to 16 from 10 in 1966. Total nonmetal mines, however, have increased in number during the interval, and those having over 10 million tons of crude ore output increased to nine from four in 1966. Copper (10), iron ore (5), and molybdenum (1) accounted for the large metal mines, and phosphate rock (7), sand and gravel (1), and stone (1) accounted for the large nonmetal mines in 1975.

Crude ore output during the 10-year period increased from 2.5 billion tons to 2.6 billion tons, and total material handled rose from 3.5 billion tons to nearly 4.2 billion tons. In addition, in 1975 there were 112 wells, ponds, or pumping operations producing 10 commodities. Output of crude ore from individual mines ranged from 1 to nearly 42 million tons, and total material handled ranged from 1 to nearly 150 million tons.

Output of crude ore at the 25 leading metal mines totaled over 403 million tons, a decrease of about 2.5% compared with that of 1974, and accounted for 66% of total crude ore from metal mines. In terms of total material handled, the 25 leading metal mines moved over 1.2 billion tons, nearly 2% less than in 1974.

Output of crude ore at the 25 leading nonmetal mines totaled nearly 218 million tons, a 10% increase compared with that of 1974. Total material handled by the 25 leading nonmetal mines totaled nearly 407 million tons, a decrease of 3% from that of 1974, and accounted for 17% of total material handled at nonmetal mines.

Three iron ore open pit mines—the Minntac of the United States Steel Corp., the Erie Commercial of Pickands Mather & Co., and the Peter Mitchell of Reserve Mining Co.—headed the list of metal mines in output of crude ore. The Minntac retained its leadership role while the Utah

Copper mine of Kennecott Copper Corp. fell to fifth place compared with the 1974 listing. The Twin Buttes mine in Arizona of Anamax Mining Co. headed a listing of mines in terms of total material handled, primarily because of stripping operations.

The Payne Creek mine of Continental Oil Co. producing phosphate rock took over the leadership in crude ore output for nonmetal mines, replacing the Suwannee mine of Occidental Petroleum Corp., which fell to second in the listing. The Haynsworth mine of American Cyanamid Co., also producing phosphate rock, was the leader in total materials handled.

Copper mines (12) and iron mines (10) dominated the list for crude ore output at metal mines, while phosphate rock mines (17) dominated the list for nonmetal mines. The same commodities headed the listings for total material handled. Arizona and Minnesota with six mines each headed the list of the 25 leading metal mines in output of crude ore, while Florida with 17 mines had the most mines in the top 25 large nonmetal mines for output of crude ore.

Materials Handled.—The U.S. mineral-producing industry, excluding fuels, handled nearly 4.2 billion tons of crude ore and waste in 1975, 9% less than in 1974 but 18% more than a decade earlier. Of the total, crude ore comprised 63%. Material handled at both metal and nonmetal mines was lower than in 1974—metals by 60 million tons and nonmetals by 350 million tons. The decrease in material handled at metal mines was primarily due to reduced activity at copper operations, while the decrease at nonmetal mines was caused by reduced demand for construction minerals.

Crude ore output at metal mines decreased 3%, while output decreased 13% at nonmetal operations. Despite the off year in crude ore production at copper mines, notable gains in crude ore production was made by gold and silver. The decrease in production at nonmetal mines resulted from lower output at sand and gravel and stone operations. Phosphate rock production, however, increased 20%.

Four commodities—copper, iron ore, titanium (ilmenite), and molybdenum—accounted for 93% of metal crude ore output and 87% of total material handled at metal mines. Clays, phosphate rock, sand and gravel, and stone furnished 96% of the crude ore and 95% of total material handled at nonmetal mines.

In 1975, 11 States each reported more than 100 million tons of total material handled, 3 fewer than in 1974. As in past years, Arizona was the leader, followed by Florida and Minnesota. Together the three States handled 33% of the U.S. total material handled. The leading States in tonnage of crude ore mined were Florida, Minnesota, and Arizona.

Value of Principal Mineral Products.—When possible, the measurement of value used in table 4 is for crude ore treated or, in the case of some nonmetals, crude ore shipped.

Average value for all commodities increased 11% compared with that of 1974. Compared with a decade earlier, average value increased 76%. For metal commodities, average values increased for about one-fourth of the commodities, but this was more than offset by a decrease in value for the other commodities; total average value decreased 2% compared with that of 1974. Among the large-volume commodities, copper decreased 17% while iron ore increased 18%. For nonmetal commodities nearly all indicated an increase in average value; overall average value rose 19%. Among the nonmetals, perlite (49%) and phosphate rock (84%) indicated significant increases in average value.

Byproducts contributed to the average value of two-thirds of the mineral commodities listed in table 4. The value of byproducts was a significant part of total value for metals such as bauxite, 50%; copper, 10%; lead, 38%; silver, 14%; and zinc, 17%, and for the nonmetals such as feldspar, 45%; fluorspar, 29%; and salt, 15%.

With the exception of talc, soapstone, and pyrophyllite, value of products at underground mines was substantially higher than at surface mines. Byproducts accounted for 10% of the average value of metal ores and 1% of nonmetal ores value. Excluding the large-volume commodities of sand and gravel and stone, byproducts contributed 2% to the value of nonmetals and 7% to the average value of metals and nonmetals. Average value for metals and nonmetals, excluding sand and gravel and stone, was 7% higher than in 1974.

Ratio of Ore Treated to Marketable Product.—The ratio of ore treated to marketable product—that is, the amount of ore processed to produce 1 unit of marketable product—varies with the type of mineral commodity. The ratio ultimately depends on the grade of ore treated and type of valuable mineral content. For many of the nonmetal commodities, the ratio is essentially 1 to 1. Ratios are significantly lower for underground mines than for surface mines for a specific commodity because of higher underground mining costs. The historical trend for most mineral commodities that are concentrated has been an increase in ratio as ores with smaller valuable mineral contents are mined and processed.

Comparison of Production From Surface and Underground Mines.—Historically, there is little annual change in the percentages of crude ore mined and total material handled by surface mines and underground mines. In 1975, surface mines accounted for 94% of crude ore production and 96% of total material handled. This compares with 94% and 95%, respectively, for crude ore and total material handled in 1966. However, changes occur for various commodities. Metal surface mine percentages for crude ore output and total material handled during the past decade increased from 83% and 92%, respectively, in 1966 to 88% and 95% in 1975. In particular, crude iron ore production from surface operations increased from 91% in 1966 to 96% in 1975, and copper crude ore output increased from 85% in 1966 to 89% in 1975.

Nonmetal mine percentages for crude ore production and total material handled have remained essentially the same because of the large-volume commodities of sand and gravel and stone. Many smaller volume nonmetal commodities, however, have shown a shift to surface operations during the 10-year period.

Two metal commodities, antimony and lead, and three nonmetal commodities, potassium salts, sodium carbonate, and wollastonite, were entirely mined by underground methods. Crude ore production of 10 metals and 19 nonmetals came entirely from surface mines.

Exploration and Development.—Exploration and development footage continued the upward trend of the previous year, increasing 22% over that of 1974. Development footage decreased slightly from that of 1974, as exploration work increased 24%. Metal exploration work increased 26%, while nonmetal exploration decreased 17% compared with that of 1974.

Metal mining accounted for 64% of the total development and 98% of the total exploration performed. The major portion of development activity for nonmetallic ores was in sodium carbonate, potassium salts, and phosphate rock, whereas the majority of development work in metallic ores was in uranium, copper, zinc, and lead. Exploration work was conducted to the greatest extent for fluorspar, phosphate rock, and gypsum for nonmetals, and for uranium, gold, copper, and zinc for metals.

The above nonmetals accounted for 97% of the total development activity and for 53% of the total exploration, while the above metals accounted for 71% and 94% of the total development and exploration activities, respectively.

Wyoming, New Mexico, South Dakota, Colorado, and Texas all had over 1 million feet of combined exploration and development activity during 1975; percentages of the total were Wyoming (28), New Mexico (26), South Dakota (13), Colorado (5), and Texas (4). Other States with significant activity were Washington, Utah, Montana, Alabama, Arizona, and Nevada.

Stripping produced the most development materials handled, accounting for 96% of the total. Arizona, from its copper activity, led with 52% of the stripped material produced. Stripping for iron ore in Michigan and Minnesota, uranium in Wyoming, and phosphate rock in Idaho contributed significant amounts to the total produced. Colorado accounted for the most material produced from shaft and winze sinking, Arizona the most from raising, and Wyoming the most from drifting, crosscutting, and tunneling.

Explosives.—Apparent consumption of industrial explosives in the United States during 1975 reached a record high for the seventh consecutive year and exceeded 3 billion pounds for the first time. Increased coal production accounted for the increased consumption as usage in all other categories decreased. Of the total industrial consumption of explosives, the minerals industry used, 83%. Coal mining consumed, 53%; quarrying and nonmetal mining, 16%; metal mining, 14%; and all other uses, 17%.

Of the nearly 2.6 billion pounds of explosives used in the minerals industry, coal mining accounted for 64%, quarrying and nonmetal mining, 19%, and metal mining, 17%.

Of the explosives consumed in the minerals industry, coal mining used 97% of the permissible explosives, 90% of cylindrical packed blasting agents, and 70% of bulk blasting agents (other processed blasting agents and unprocessed ammonium nitrate). Other high explosives were consumed primarily in quarrying and nonmetal mining, 55%. The chief use of water gels and slurries was in metal mining, 65%.

Kentucky, Pennsylvania, and Alabama were the leading States in explosive consumption for coal mining, accounting for 55% of the total. Arizona, Minnesota, and New Mexico were leading States in consumption of explosives for metal mining, accounting for 63% of the total. For quarrying and nonmetal mining, Ohio, Pennsylvania, and Illinois were leading States, accounting for 24% of the explosives used in this category.

More detailed explosives information is published in the Annual Explosive issue of Mineral Industry Surveys, prepared by the Division of Nonmetallic Minerals, Bureau of Mines.

Table 1.—Material handled at surface and underground mines in the United States, by type
(Million short tons)

Type and year	Surface			Underground			All mines [1]		
	Crude ore	Waste	Total [1]	Crude ore	Waste	Total [1]	Crude ore	Waste	Total
Metals:									
1960	336	508	844	86	8	94	421	516	938
1961	340	415	755	83	7	91	423	422	846
1962	346	434	780	76	7	83	422	441	863
1963	354	463	817	76	7	83	430	470	900
1964	376	455	830	83	7	90	458	462	920
1965	390	505	895	87	6	94	477	511	989
1966	412	634	1,050	88	7	95	500	641	1,140
1967	353	619	972	74	7	81	427	626	1,050
1968	402	717	1,120	79	13	92	481	730	1,210
1969	455	941	1,400	85	13	98	540	954	1,490
1970	499	968	1,470	87	7	94	586	975	1,560
1971	480	1,020	1,500	80	6	86	560	1,020	1,580
1972	491	1,080	1,570	86	5	91	576	1,080	1,660
1973	574	1,280	1,860	82	9	91	655	1,290	1,950
1974	547	1,210	1,760	80	11	91	627	1,220	1,850
1975	535	1,170	1,700	74	13	87	609	1,180	1,790
Nonmetals:									
1960	1,550	236	1,790	57	1	58	1,610	236	1,850
1961	1,590	188	1,780	65	1	66	1,660	190	1,850
1962	1,590	224	1,810	62	1	63	1,650	225	1,880
1963	1,640	261	1,900	67	2	69	1,710	263	1,970
1964	1,740	277	2,010	69	2	71	1,800	279	2,080
1965	1,850	296	2,140	78	3	81	1,930	299	2,220
1966	1,930	368	2,300	77	2	79	2,010	370	2,380
1967	1,910	399	2,310	78	3	81	1,990	402	2,390
1968	1,870	413	2,280	78	3	81	1,950	416	2,360
1969	2,000	375	2,380	80	2	82	2,080	377	2,460
1970	2,010	431	2,440	80	4	84	2,090	435	2,530
1971	1,980	442	2,420	73	5	78	2,050	447	2,500
1972	2,020	415	2,430	77	5	82	2,100	420	2,520
1973	2,240	418	2,650	82	1	83	2,320	419	2,740
1974	2,220	418	2,640	82	5	87	2,300	423	2,720
1975	1,910	372	2,290	79	6	84	1,990	378	2,370
Total metals and nonmetals: [1]									
1960	1,890	744	2,630	143	9	152	2,030	753	2,780
1961	1,930	603	2,540	148	9	156	2,080	612	2,690
1962	1,940	658	2,590	138	8	146	2,070	666	2,740
1963	1,990	724	2,720	142	9	152	2,140	734	2,870
1964	2,110	731	2,840	152	9	161	2,260	740	3,000
1965	2,240	801	3,040	165	9	175	2,400	810	3,210
1966	2,340	1,000	3,340	165	9	174	2,510	1,010	3,520
1967	2,260	1,020	3,280	152	10	162	2,410	1,030	3,440
1968	2,270	1,130	3,400	157	16	173	2,430	1,150	3,580
1969	2,460	1,320	3,770	165	15	180	2,620	1,330	3,950
1970	2,510	1,400	3,910	167	11	178	2,680	1,410	4,090
1971	2,460	1,460	3,920	153	11	164	2,610	1,470	4,080
1972	2,500	1,500	4,000	163	10	173	2,670	1,510	4,180
1973	2,810	1,700	4,510	163	11	174	2,970	1,710	4,680
1974	2,760	1,630	4,390	162	16	178	2,930	1,650	4,570
1975	2,450	1,540	3,990	153	18	171	2,600	1,560	4,160

[1] Data may not add to totals shown because of independent rounding.

Table 2.—Material handled at surface and underground mines in 1975, by commodity [1]

(Thousand short tons)

Commodity	Surface			Underground			All mines [2]		
	Crude ore	Waste	Total [2]	Crude ore	Waste	Total [2]	Crude ore	Waste	Total
METALS									
Bauxite	3,290	13,300	16,600	W	--	W	3,290	13,300	16,600
Copper	240,000	689,000	928,000	29,200	1,360	30,600	269,000	690,000	959,000
Gold:									
Lode	3,950	7,940	11,900	1,570	210	1,780	5,520	8,150	13,700
Placer	4,600	1,090	5,690	--	2	2	4,600	1,090	5,690
Iron ore	230,000	256,000	486,000	9,080	1,890	11,000	239,000	258,000	497,000
Lead	4	(3)	4	9,850	2,450	12,300	9,850	2,450	12,300
Mercury	59	509	568	4	(3)	4	63	509	572
Silver	311	21	332	790	348	1,140	1,100	370	1,470
Titanium, ilmenite	32,800	3,600	36,400	--	--	--	32,800	3,600	36,400
Tungsten	6	10	16	575	63	637	581	73	654
Uranium	4,200	154,000	159,000	2,740	2,420	5,160	6,940	157,000	164,000
Zinc	81	42	124	8,490	2,740	11,200	8,580	2,780	11,400
Other [4]	15,800	40,600	56,300	12,000	1,110	13,100	27,700	41,700	69,400
Total metals [2]	535,000	1,170,000	1,700,000	74,300	12,600	86,900	609,000	1,180,000	1,790,000
NONMETALS									
Abrasives [5]	268	447	715	44	(3)	44	312	447	758
Asbestos	1,450	250	1,700	W	--	W	1,450	250	1,700
Barite	1,900	2,140	4,040	W	W	W	1,900	2,140	4,040
Clays	42,700	[e] 37,100	79,800	696	[e] 10	706	43,400	37,100	80,500
Diatomite	872	849	1,720	--	--	--	872	849	1,720
Feldspar	1,310	1,980	3,290	--	--	--	1,310	1,980	3,290
Fluorspar	19	49	68	492	33	525	511	82	593
Gypsum	8,180	13,400	21,600	1,950	206	2,160	10,100	13,600	23,800
Mica (scrap)	521	254	776	--	--	--	521	254	776
Perlite	706	20	726	--	--	--	706	20	726
Phosphate rock	186,000	216,000	402,000	W	W	W	186,000	216,000	402,000
Potassium salts	--	--	--	17,800	460	18,300	17,800	460	18,300
Pumice	3,890	118	4,010	--	--	--	3,890	118	4,010
Salt	479	87	566	14,500	617	15,100	14,900	704	15,600
Sand and gravel	789,000	--	789,000	--	--	--	789,000	--	789,000
Sodium carbonate (natural)	--	--	--	8,010	4,050	12,100	8,010	4,050	12,100

Stone:									
Crushed and broken	865,000	[e] 71,200	937,000	34,600	[e] 300	34,800	899,000	71,500	971,000
Dimension	[e] 2,290	[e] 1,210	3,500	42	--	42	2,330	1,210	3,540
Talc, soapstone, pyrophyllite	484	1,760	2,240	161	9	171	645	1,770	2,410
Other [6]	7,340	25,100	32,400	422	76	497	7,760	25,200	32,900
Total nonmetals [2]	1,910,000	372,000	2,290,000	78,700	5,760	84,400	1,990,000	378,000	2,370,000
Grand total [2]	2,450,000	1,540,000	3,990,000	153,000	18,400	171,000	2,600,000	1,560,000	4,160,000

[e] Estimate. W Withheld to avoid disclosing individual company confidential data.
[1] Excludes material from wells, ponds, or pumping operations.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than ½ unit.
[4] Antimony, beryllium, manganiferous ore, molybdenum, monazite, nickel, platinum-group metals, rare-earth metals, tin, vanadium, and quantity of metal items indicated by symbol W.
[5] Abrasive stone, emery, garnet, and tripoli.
[6] Aplite, boron minerals, graphite, greensand marl, iron oxide pigments (crude), kyanite, lithium minerals, magnesite, millstones, olivine, vermiculite, and quantity of nonmetal items indicated by symbol W.

Table 3.—Material handled at surface and underground mines (including sand and gravel and stone) in 1975, by State [1]

(Thousand short tons)

State	Surface			Underground			All mines [2]		
	Crude ore	Waste	Total [2]	Crude ore	Waste	Total [2]	Crude ore	Waste	Total
Alabama	33,800	12	33,800	W	--	W	33,800	12	33,800
Alaska	60,900	1,150	62,100	--	1	1	60,900	1,150	62,100
Arizona	169,000	431,000	600,000	17,900	1,110	19,000	187,000	432,000	619,000
Arkansas	33,100	14,300	47,400	725	58	782	33,800	14,300	48,200
California	142,000	66,500	208,000	743	80	822	142,000	66,600	209,000
Colorado	29,600	14,300	43,900	13,400	1,910	15,300	43,000	16,200	59,200
Connecticut	12,500	13	12,500	--	--	--	12,500	13	12,500
Delaware	985	--	985	--	--	--	985	--	985
Florida	241,000	144,000	384,000	--	--	--	241,000	144,000	384,000
Georgia	45,800	2,010	47,800	594	--	594	46,400	2,010	48,400
Hawaii	8,350	--	8,350	--	--	--	8,350	--	8,350
Idaho	16,800	28,100	44,900	1,810	636	2,450	18,600	28,800	47,400
Illinois	98,500	49	98,600	2,830	33	2,860	101,000	82	101,000
Indiana	50,300	--	50,300	1,380	6	1,380	51,700	6	51,700
Iowa	44,700	2,770	47,500	2,750	--	2,750	47,500	2,770	50,200
Kansas	26,200	--	26,200	2,530	--	2,530	28,700	--	28,700
Kentucky	34,700	--	34,700	6,950	--	6,950	41,600	--	41,600
Louisiana	25,700	373	26,100	5,840	136	5,970	31,600	509	32,100
Maine	11,300	--	11,300	W	W	W	11,300	--	11,300
Maryland	27,000	--	27,000	W	--	W	27,000	--	27,000
Massachusetts	20,600	--	20,600	--	--	--	20,600	--	20,600
Michigan	132,000	46,000	178,000	12,300	229	12,500	144,000	46,200	191,000
Minnesota	201,000	149,000	349,000	--	--	--	201,000	149,000	349,000
Mississippi	17,600	--	17,600	--	--	--	17,600	--	17,600
Missouri	52,200	1,370	53,600	20,100	2,920	23,000	72,300	4,290	76,600
Montana	28,500	57,800	86,300	729	72	801	29,300	57,900	87,100
Nebraska	15,200	--	15,200	994	--	994	16,200	--	16,200
Nevada	44,900	55,900	101,000	437	13	450	45,400	55,900	101,000
New Hampshire	6,700	--	6,700	--	--	--	6,700	--	6,700
New Jersey	31,900	357	32,200	W	--	W	31,900	357	32,200
New Mexico	36,600	105,000	141,000	20,100	1,690	21,800	56,800	106,000	163,000
New York	58,500	4,230	62,800	5,350	125	5,480	63,900	4,360	68,200
North Carolina	45,500	23,200	68,700	--	--	--	45,500	23,200	68,700
North Dakota	5,720	--	5,720	--	--	--	5,720	--	5,720
Ohio	85,400	29	85,400	4,610	478	5,080	90,000	506	90,500
Oklahoma	30,800	1,030	31,800	W	--	W	30,800	1,030	31,800
Oregon	41,900	853	42,800	6	7	12	41,900	860	42,800
Pennsylvania	76,200	9	76,200	5,780	828	6,600	82,000	837	82,800
Rhode Island	3,200	--	3,200	--	--	--	3,200	--	3,200
South Carolina	23,000	--	23,000	--	--	--	23,000	--	23,000
South Dakota	9,530	--	9,530	1,490	160	1,650	11,000	160	11,200
Tennessee	53,700	9,660	63,300	7,050	1,080	8,140	60,700	10,700	71,500
Texas	105,000	30,600	136,000	643	--	643	106,000	30,600	136,000
Utah	45,500	113,000	159,000	912	758	1,670	46,500	114,000	160,000
Vermont	4,880	199	5,080	152	2	153	5,040	201	5,240
Virginia	45,600	90	45,700	1,540	1,010	2,540	47,200	1,100	48,300
Washington	27,300	1,410	28,800	365	156	521	27,700	1,570	29,300

West Virginia	13,600	--	13,600	2,400	--	2,400	16,000	--	16,000
Wisconsin	52,900	4,300	57,200	597	42	640	53,500	4,350	57,800
Wyoming	18,200	122,000	140,000	8,310	4,340	12,700	26,500	126,000	152,000
Undistributed[3]	1,260	110,000	111,000	1,680	469	2,150	2,940	110,000	113,000
Total[2]	2,450,000	1,540,000	3,990,000	153,000	18,400	171,000	2,600,000	1,560,000	4,160,000

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Excludes material from wells, ponds, or pumping operations.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes estimated data in table 2.

Table 4.—Value of principal mineral products and byproducts of surface and underground ores mined in the United States in 1975

(Value per ton)

Ore	Surface			Underground			All mines		
	Principal mineral product	By-product	Total	Principal mineral product	By-product	Total	Principal mineral product	By-product	Total
METALS									
Bauxite	$6.83	$6.94	$13.77	W	--	W	$6.83	$6.94	$13.77
Copper	6.31	.70	7.01	$10.38	$1.09	$11.47	6.77	.74	7.51
Gold:									
Lode	12.62	.10	12.72	34.61	.59	35.20	18.91	.24	19.15
Placer	.71	--	.71	--	--	--	.71	--	.71
Iron ore	6.55	--	6.55	14.57	.10	14.67	6.86	--	6.86
Lead	12.69	6.24	18.93	24.81	15.29	40.10	24.80	15.28	40.08
Mercury	3.26	--	3.26	12.95	--	12.95	3.39	--	3.39
Silver	1.80	1.97	3.77	63.43	10.08	73.51	46.73	7.88	54.61
Titanium, ilmenite	.81	.74	1.55	--	--	--	.81	.74	1.55
Uranium	35.37	.08	35.45	41.65	6.95	48.60	37.95	2.89	40.84
Zinc	--	--	--	30.64	6.38	37.02	30.35	6.32	36.67
Average [1]	6.26	.40	6.66	18.02	3.74	21.76	7.73	.82	8.55
NONMETALS									
Asbestos	10.38	--	10.38	W	--	W	10.38	--	10.38
Barite	11.18	.13	11.31	W	--	W	11.18	.13	11.31
Clays	8.99	.05	9.04	10.12	--	10.12	9.00	.05	9.05
Diatomite	79.15	--	79.15	--	--	--	79.15	--	79.15
Feldspar	6.09	4.89	10.98	--	--	--	6.09	4.89	10.98
Fluorspar	37.92	--	37.92	22.52	10.17	32.69	23.44	9.56	33.00
Gypsum	4.13	.13	4.26	5.32	--	5.32	4.36	.10	4.46
Mica (scrap)	4.37	--	4.37	--	--	--	4.37	--	4.37
Perlite	13.80	--	13.80	--	--	--	13.80	--	13.80
Phosphate rock	6.01	.05	6.06	W	--	W	6.01	.05	6.06
Potassium salts	--	--	--	10.10	.03	10.13	10.10	.03	10.13
Pumice	2.87	--	2.87	--	--	--	2.87	--	2.87
Salt	2.19	1.08	3.27	7.50	1.31	8.81	7.36	1.31	8.67
Sand and gravel	1.79	--	1.79	--	--	--	1.79	--	1.79
Sodium carbonate (natural)	--	--	--	22.04	--	22.04	22.04	--	22.04
Stone:									
Crushed and broken	2.24	.01	2.25	2.81	.01	2.82	2.26	.01	2.27
Dimension	68.32	--	68.32	96.26	--	96.26	69.40	--	69.40
Talc, soapstone, pyrophyllite	7.32	--	7.32	7.30	--	7.30	7.31	--	7.31
Average [1]	2.74	.02	2.76	7.60	.30	7.90	2.93	.03	2.96
Average, metals and nonmetals [1]	3.50	.10	3.60	12.71	1.98	14.69	4.04	.21	4.25
Average, nonmetals (excluding stone and sand and gravel) [1]	7.12	.09	7.21	11.35	.54	11.89	7.74	.15	7.89
Average, metals and nonmetals (excluding stone and sand and gravel) [1]	6.54	.30	6.84	15.58	2.56	18.14	7.73	.60	8.33

W Withheld to avoid disclosing individual company confidential data.
[1] Includes unpublished data.

Table 5.—Crude ore and total material handled at surface and underground mines in 1975, by commodity
(Percent)

Commodity	Crude ore		Total material	
	Surface	Underground	Surface	Underground
METALS				
Antimony	--	100.0	--	100.0
Bauxite	[1]100.0	W	[1]100.0	W
Beryllium	100.0	--	100.0	--
Copper	89.1	10.9	96.8	3.2
Gold:				
Lode	71.6	28.4	87.0	13.0
Placer	100.0	--	100.0	--
Iron ore	96.2	3.8	97.8	2.2
Lead	--	100.0	--	100.0
Manganiferous ore	100.0	--	100.0	--
Mercury	93.4	6.6	99.3	.7
Molybdenum	47.8	52.2	78.4	21.6
Nickel	100.0	--	100.0	--
Platinum-group metals	100.0	--	98.9	1.1
Rare-earth metals	100.0	--	100.0	--
Silver	28.3	71.7	22.8	77.2
Tin	100.0	--	100.0	--
Titanium, ilmenite	100.0	--	100.0	--
Tungsten	1.1	98.9	2.5	97.5
Uranium	60.6	39.4	96.8	3.2
Vanadium	100.0	--	100.0	--
Zinc	.9	99.1	1.1	98.9
Total metals	87.8	12.2	95.1	4.9
NONMETALS				
Abrasive stone	100.0	--	100.0	--
Aplite	100.0	--	100.0	--
Asbestos	[1]100.0	W	[1]100.0	W
Barite	[1]100.0	W	[1]100.0	W
Boron minerals	100.0	--	100.0	--
Clays	98.4	1.6	98.4	1.6
Diatomite	100.0	--	100.0	--
Emery	100.0	--	100.0	--
Feldspar	100.0	--	100.0	--
Fluorspar	3.8	96.2	11.5	88.5
Garnet	100.0	--	100.0	--
Graphite	100.0	--	100.0	--
Greensand marl	100.0	--	100.0	--
Gypsum	80.8	19.2	90.9	9.1
Iron oxide pigments (crude)	18.9	81.1	18.9	81.1
Kyanite	100.0	--	100.0	--
Lithium minerals	100.0	--	100.0	--
Magnesite	100.0	--	100.0	--
Mica (scrap)	100.0	--	100.0	--
Millstones	100.0	--	100.0	--
Olivine	100.0	--	100.0	--
Perlite	100.0	--	100.0	--
Phosphate rock	[1]100.0	W	[1]100.0	W
Potassium salts	--	100.0	--	100.0
Pumice	100.0	--	100.0	--
Salt	3.2	96.8	3.6	96.4
Sand and gravel	100.0	--	100.0	--
Sodium carbonate (natural)	--	100.0	--	100.0
Stone:				
Crushed and broken	96.2	3.8	96.4	3.6
Dimension	96.1	3.9	96.1	3.9
Talc, soapstone, pyrophyllite	75.0	25.0	92.9	7.1
Tripoli	46.5	53.5	65.4	34.6
Vermiculite	100.0	--	100.0	--
Wollastonite	--	100.0	--	100.0
Total nonmetals	96.0	4.0	96.2	3.8
Grand total	94.1	5.9	95.7	4.3

W Withheld to avoid disclosing individual company confidential data; included with "Surface."
[1] Includes underground; the Bureau of Mines is not at liberty to publish separately.

Table 6.—Crude ore and total material handled at surface and underground mines in 1975, by State

(Percent)

State	Crude ore		Total material	
	Surface	Underground	Surface	Underground
Alabama	[1]100	W	[1]100	W
Alaska	100	--	100	--
Arizona	90	10	97	3
Arkansas	98	2	98	2
California	100	--	100	--
Colorado	69	31	74	26
Connecticut	100	--	100	--
Delaware	100	--	100	--
Florida	100	--	100	--
Georgia	99	1	99	1
Hawaii	100	--	100	--
Idaho	90	10	95	5
Illinois	97	3	97	3
Indiana	97	3	97	3
Iowa	94	6	95	5
Kansas	91	9	91	9
Kentucky	83	17	83	17
Louisiana	82	18	81	19
Maine	[1]100	W	[1]100	W
Maryland	[1]100	W	[1]100	W
Massachusetts	100	--	100	--
Michigan	92	8	93	7
Minnesota	100	--	100	--
Mississippi	100	--	100	--
Missouri	72	28	82	18
Montana	98	2	99	1
Nebraska	94	6	94	6
Nevada	99	1	100	--
New Hampshire	100	--	100	--
New Jersey	[1]100	W	[1]100	W
New Mexico	65	35	87	13
New York	92	8	92	8
North Carolina	100	--	100	--
North Dakota	100	--	100	--
Ohio	95	5	94	6
Oklahoma	[1]100	W	[1]100	W
Oregon	100	--	100	--
Pennsylvania	93	7	92	8
Rhode Island	100	--	100	--
South Carolina	100	--	100	--
South Dakota	87	13	85	15
Tennessee	88	12	89	11
Texas	99	1	100	--
Utah	98	2	99	1
Vermont	97	3	97	3
Virginia	97	3	95	5
Washington	99	1	98	2
West Virginia	85	15	85	15
Wisconsin	99	1	99	1
Wyoming	69	31	92	8
Total	94	6	96	4

W Withheld to avoid disclosing individual company confidential data; included with "Surface."
[1] Includes underground; the Bureau of Mines is not at liberty to publish separately.

Table 7.—Number of domestic metal and nonmetal mines in 1975, by commodity and magnitude of crude ore production [1]

Commodity	Total number of mines	Less than 1,000 tons	1,000 to 10,000 tons	10,000 to 100,000 tons	100,000 to 1,000,000 tons	1,000,000 to 10,000,000 tons	More than 10,000,000 tons
METALS							
Bauxite	12	--	--	7	5	--	--
Copper	61	12	3	5	9	22	10
Gold:							
Lode	57	36	11	4	4	2	--
Placer	42	16	12	9	2	3	--
Iron ore	68	--	8	13	17	25	5
Lead	33	13	4	3	8	5	--
Mercury	12	6	5	1	--	--	--
Silver	64	42	11	7	4	--	--
Tin	2	2	--	--	--	--	--
Titanium, ilmenite	7	--	--	--	1	6	--
Tungsten	41	37	3	--	1	--	--
Uranium	164	27	68	48	21	--	--
Zinc	36	3	3	8	21	1	--
Other [2]	10	2	--	2	2	3	1
Total metals	609	196	128	107	95	67	16
NONMETALS							
Abrasives [3]	12	2	6	3	1	--	--
Asbestos	3	--	1	--	1	1	--
Barite	41	1	13	19	8	--	--
Boron minerals	2	--	--	--	1	1	--
Clays	1,249	80	370	698	101	--	--
Diatomite	15	2	7	3	3	--	--
Feldspar	18	3	1	9	5	--	--
Fluorspar	12	2	6	2	2	--	--
Gypsum	68	--	6	28	34	--	--
Mica (scrap)	12	2	6	1	3	--	--
Perlite	12	1	4	5	2	--	--
Phosphate rock	47	1	8	2	13	16	7
Potassium salts	8	--	--	1	1	6	--
Pumice	224	37	78	104	5	--	--
Salt	19	--	2	2	8	7	--
Sand and gravel	7,007	169	1,168	3,647	1,967	55	1
Sodium carbonate (natural)	3	--	--	--	--	3	--
Stone:							
Crushed and broken	5,203	342	972	2,040	1,727	121	1
Dimension	381	204	153	24	--	--	--
Talc, soapstone, pyrophyllite	40	6	20	13	1	--	--
Other [4]	29	8	3	13	4	1	--
Total nonmetals	14,405	860	2,824	6,614	3,887	211	9
Grand total	15,014	1,056	2,952	6,721	3,982	278	25

[1] Excludes wells, ponds, or pumping operations.
[2] Antimony, manganiferous ore, molybdenum, monazite, nickel, platinum-group metals, rare-earth metals, and vanadium.
[3] Abrasive stone, emery, garnet, and tripoli.
[4] Aplite, graphite, greensand marl, iron oxide pigments (crude), kyanite, lithium minerals, magnesite, millstones, olivine, and vermiculite.

Table 8.—Twenty-five leading metal and nonmetal[1] mines in the United States in 1975, in order of output of crude ore

Mine	State	Operator	Commodity	Mining method
		METALS		
Minntac	Minnesota	United States Steel Corp	Iron ore	Open pit.
Erie Commercial (Hoyt Lake).	do	Pickands Mather & Co	do	Do.
Peter Mitchell	do	Reserve Mining Co	do	Do.
Sierrita	Arizona	Duval Sierrita Corp	Copper	Do.
Utah Copper	Utah	Kennecott Copper Corp	do	Do.
Pima	Arizona	Cyprus Pima Mining Co	do	Do.
San Manuel	do	Magma Copper Co	do	Caving.
Empire	Michigan	Cleveland-Cliffs Iron Co	Iron ore	Open pit.
Morenci	Arizona	Phelps Dodge Corp	Copper	Do.
Berkeley Pit	Montana	The Anaconda Company	do	Do.
Climax	Colorado	Climax Molybdenum Co., a division of AMAX Inc.	Molybdenum	Caving and open pit.
Pinto Valley	Arizona	Cities Service Co	Copper	Open pit.
Tyrone	New Mexico	Phelps Dodge Corp	do	Do.
Copper Canyon	Nevada	Duval Corp	do	Do.
Tilden	Michigan	Cleveland Cliffs Iron Co	Iron ore	Do.
Yerington	Nevada	The Anaconda Company	Copper	Do.
Eagle Mountain	California	Kaiser Steel Corp	Iron ore	Do.
White Pine	Michigan	White Pine Copper Co	Copper	Open stopes.
Republic	do	Cleveland-Cliffs Iron Co	Iron ore	Open pit.
Butler Project	Minnesota	Hanna Mining Co	do	Do.
Highland	Florida	E. I. du Pont de Nemours & Co.	Titanium	Dredging.
Questa	New Mexico	Molybdenum Corp. of America.	Molybdenum	Open pit.
National Steel Pellet Project.	Minnesota	Hanna Mining Co	Iron ore	Do.
New Cornelia	Arizona	Phelps Dodge Corp	Copper	Do.
Thunderbird	Minnesota	Oglebay Norton Co	Iron ore	Do.
		NONMETALS		
Payne Creek	Florida	Continental Oil Co	Phosphate rock.	Open pit.
Suwannee	do	Occidental Petroleum Corp.	do	Do.
Noralyn	do	International Minerals & Chemical Corp.	do	Do.
Kingsford	do	do	do	Do.
Ft. Meade	do	Mobil Oil Corp	do	Do.
Calcite	Michigan	United States Steel Corp.	Stone	Open quarry.
Haynsworth	Florida	American Cyanamid Co	Phosphate rock.	Open pit.
Palmetto	do	Continental Oil Co	do	Do.
Clear Spring	do	International Minerals & Chemical Corp.	do	Do.
Rockland	do	United States Steel Corp.	do	Do.
Ft. Green	do	Continental Oil Co	do	Do.
Stoneport	Michigan	Presque Isle Corp	Stone	Open quarry.
Thornton	Illinois	General Dynamics Corp	do	Do.
Tampa Agricultural Chemical Operations.	Florida	Gardinier, Inc	Phosphate rock.	Open pit.
Feld	Texas	Texas Crushed Stone Co.	Stone	Open quarry.
Saddle Creek	Florida	Continental Oil Co	Phosphate rock.	Open pit.
Nichols	do	Mobil Oil Corp	do	Do.
Silver City	do	Swift Agricultural Chemicals Corp.	do	Do.
Bonny Lake	do	W. R. Grace & Co	do	Do.
Lee Creek	North Carolina	Texasgulf Inc	do	Do.
International	New Mexico	International Minerals & Chemical Corp.	Potassium salts.	Open stopes.
Tenoroc	Florida	Borden, Inc	Phosphate rock.	Open pit.
Alpena	Michigan	Huron Portland Cement Co.	Stone	Open quarry.
Beckman	Texas	McDonough Bros., Inc	do	Do.
Pennsuco	Florida	Maule Industries, Inc	do	Dredging.

[1] Brines and materials from wells excepted.

Table 9.—Twenty-five leading metal and nonmetal[1] mines in the United States in 1975, in order of output of total materials handled

Mine	State	Operator	Commodity	Mining method
		METALS		
Twin Buttes	Arizona	Anamax Mining Co	Copper	Open pit.
Utah Copper	Utah	Kennecott Copper Corp	do	Do.
Minntac	Minnesota	United States Steel Corp	Iron ore	Do.
Sierrita	Arizona	Duval Sierrita Corp	Copper	Do.
Berkeley Pit	Montana	The Anaconda Company	do	Do.
Pima	Arizona	Cyprus Pima Mining Co.	do	Do.
Eagle Mountain	California	Kaiser Steel Corp	Iron ore	Do.
Erie Commercial (Hoyt Lake).	Minnesota	Pickands Mather & Co	do	Do.
Tyrone	New Mexico	Phelps Dodge Corp	Copper	Do.
Mitchell Pit	Minnesota	Reserve Mining Co	Iron ore	Do.
Morenci	Arizona	Phelps Dodge Corp	Copper	Do.
Pinto Valley	do	Cities Service Co	do	Do.
Shirley Basin	Wyoming	Utah International Inc	Uranium	Do.
Empire	Michigan	Cleveland-Cliffs Iron Co	Iron ore	Do.
Ruth	Nevada	Kennecott Copper Corp	Copper	Do.
Ray Pit	Arizona	do	do	Do.
Climax	Colorado	Climax Molybdenum Co., a division of AMAX Inc.	Molybdenum	Caving and open pit.
Questa	New Mexico	Molybdenum Corp. of America.	do	Open pit.
Chino	do	Kennecott Copper Corp	Copper	Do.
4–T	Wyoming	Utah International Inc	Uranium	Do.
Republic	Michigan	Cleveland-Cliffs Iron Co	Iron ore	Do.
Sacaton	Arizona	ASARCO, Inc	Copper	Do.
Inspiration	do	Inspiration Consolidated Copper Corp.	do	Do.
Highland	Wyoming	Exxon Corp	Uranium	Do.
Metcalf	Arizona	Phelps Dodge Corp	Copper	Do.
		NONMETALS		
Haynsworth	Florida	American Cyanamid Co	Phosphate rock.	Open pit.
Suwannee	do	Occidental Petroleum Corp.	do	Do.
Rockland	do	United States Steel Corp	do	Do.
Payne Creek	do	Continental Oil Co	do	Do.
Bonny Lake	do	W. R. Grace & Co	do	Do.
Lee Creek	North Carolina	Texasgulf Inc	do	Do.
Ft. Meade	Florida	Mobil Oil Corp	do	Do.
Palmetto	do	Continental Oil Corp	do	Do.
Tampa Agricultural Chemical Operations.	do	Gardinier, Inc	do	Do.
Noralyn	do	International Minerals & Chemical Corp.	do	Do.
Boron	California	U.S. Borax & Chemical Corp.	Boron	Do.
Kingsford	Florida	International Minerals & Chemical Corp.	Phosphate rock.	Do.
Ft. Green	do	Continental Oil Corp	do	Do.
Nichols	do	Mobil Oil Corp	do	Do.
Silver City	do	Swift Agricultural Chemicals Corp.	do	Do.
Calcite	Michigan	United States Steel Corp	Stone	Open quarry.
Watson	Florida	Swift Agricultural Chemicals Corp.	Phosphate rock.	Open pit.
Saddle Creek	do	Continental Oil Corp	do	Do.
Clear Spring	do	International Minerals & Chemical Corp.	do	Do.
Gay	Idaho	J. R. Simplot Co	do	Do.
Wooley Valley	do	Stauffer Chemical Co	do	Do.
Conda	do	J. R. Simplot Co	do	Do.
Vernal	do	Stauffer Chemical Co	do	Do.
Stoneport	Michigan	Presque Isle Corp	Stone	Open quarry.
Westvaco	Wyoming	FMC Corp	Sodium carbonate.	Artificial stopes.

[1] Brines and materials from wells excepted.

Table 10.—Ore treated or sold per unit of marketable product at surface and underground mines in the United States in 1975, by commodity

Commodity	Unit of marketable product	Surface			Underground			Total [1]		
		Ore treated (thousand short tons)	Marketable product (units)	Ratio of units of ore to units of marketable product	Ore treated (thousand short tons)	Marketable product (units)	Ratio of units of ore to units of marketable product	Ore treated (thousand short tons)	Marketable product (units)	Ratio of units of ore to units of marketable product
METALS										
Bauxite	thousand long tons	3,440	1,690	2.0:1	W	W	W	3,440	1,690	2.0:1
Copper	thousand short tons	234,000	1,150	203.4:1	29,300	237	123.7:1	263,000	1,390	189.7:1
Gold:										
Lode	thousand troy ounces	3,880	303	12.8:1	1,550	333	4.7:1	5,430	636	8.5:1
Placer	do	4,590	20	227.2:1	--	--	--	4,590	20	227.2:1
Iron ore	thousand long tons	227,000	70,700	3.2:1	9,100	4,760	1.9:1	236,000	75,400	3.1:1
Lead	thousand short tons	7	(2)	33.9:1	9,840	568	17.3:1	9,850	568	17.3:1
Mercury	thousand flasks	323	7	48.4:1	4	(2)	12.2:1	327	7	46.7:1
Silver	thousand troy ounces	311	127	2.5:1	838	12,000	0.1:1	1,150	12,200	0.1:1
Titanium, ilmenite	thousand short tons	33,100	702	47.2:1	--	--	--	33,100	702	47.2:1
Uranium	do	4,370	6	695.4:1	3,040	5	590.6:1	7,410	11	648.3:1
Zinc	do	81	--	--	8,480	333	25.5:1	8,560	333	25.7:1
NONMETALS										
Asbestos	do	1,300	97	13.4:1	W	W	W	1,300	97	13.4:1
Barite	do	1,720	1,220	1.4:1	W	W	W	1,720	1,220	1.4:1
Clays	do	42,700	42,700	1.0:1	696	696	1.0:1	43,400	43,400	1.0:1
Diatomite	do	579	573	1.0:1	--	--	--	579	573	1.0:1
Feldspar	do	1,940	683	2.8:1	--	--	--	1,940	683	2.8:1
Fluorspar	do	28	22	1.3:1	437	118	3.7:1	464	140	3.3:1
Gypsum	do	8,240	7,700	1.1:1	2,010	2,050	1.0:1	10,200	9,750	1.1:1
Mica (scrap)	do	521	66	7.9:1	--	--	--	521	66	7.9:1
Perlite	do	528	511	1.0:1	--	--	--	528	511	1.0:1
Phosphate rock	do	186,000	48,500	3.8:1	W	W	W	186,000	48,500	3.8:1
Potassium salts	do	--	--	--	17,800	2,080	8.6:1	17,800	2,080	8.6:1
Pumice	do	3,900	3,890	1.0:1	--	--	--	3,900	3,890	1.0:1
Salt	do	382	196	2.0:1	14,000	13,800	1.0:1	14,400	14,000	1.0:1
Sand and gravel	do	789,000	789,000	1.0:1	--	--	--	789,000	789,000	1.0:1
Sodium carbonate (natural)	do	--	--	--	7,690	4,040	1.9:1	7,690	4,040	1.9:1
Stone:										
Crushed and broken	do	871,000	866,000	1.0:1	34,600	34,500	1.0:1	906,000	900,000	1.0:1
Dimension	do	e 2,290	1,040	2.2:1	42	42	1.0:1	2,330	1,080	2.2:1
Talc, soapstone, pyrophyllite	do	503	387	1.3:1	161	162	1.0:1	664	549	1.2:1

e Estimate. W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.

Table 11.—Material handled per unit of marketable product at surface and underground mines in the United States in 1975, by commodity

Commodity	Unit of marketable product	Surface: Total material handled (thousand short tons)	Surface: Marketable product (units)	Surface: Ratio of units of material handled to units of marketable product	Underground: Total material handled (thousand short tons)	Underground: Marketable product (units)	Underground: Ratio of units of material handled to units of marketable product	Total[1]: Total material handled (thousand short tons)	Total[1]: Marketable product (units)	Total[1]: Ratio of units of material handled to units of marketable product
METALS										
Bauxite	thousand long tons	16,600	1,690	8.7:1	W	W	W	16,600	1,690	8.7:1
Copper	thousand short tons	928,000	1,150	667.8:1	30,600	237	124.0:1	959,000	1,390	574.7:1
Gold:										
Lode	thousand troy ounces	11,900	303	39.1:1	1,780	333	4.7:1	13,700	636	21.1:1
Placer	do	5,690	20	276.8:1	2	--	--	5,690	20	276.8:1
Iron ore	thousand long tons	486,000	70,700	6.4:1	11,000	4,760	2.1:1	497,000	75,400	6.1:1
Lead	thousand short tons	5	(2)	19.5:1	12,300	568	18.5:1	12,300	568	18.5:1
Mercury	thousand flasks	568	7	46.9:1	4	(2)	12.2:1	572	7	45.2:1
Silver	thousand troy ounces	337	127	2.5:1	1,140	12,000	0.1:1	1,480	12,200	0.1:1
Titanium, ilmenite	thousand short tons	36,400	702	51.9:1	--	--	--	36,400	702	51.9:1
Uranium	do	159,000	6	13,410.2:1	5,160	5	768.4:1	164,000	11	7,723.7:1
Zinc	do	124	--	--	11,200	333	28.8:1	11,400	333	29.0:1
NONMETALS										
Asbestos	do	1,700	97	17.0:1	W	W	W	1,700	97	17.0:1
Barite	do	4,050	1,220	3.3:1	W	W	W	4,050	1,220	3.3:1
Clays	do	[e] 79,800	42,700	1.9:1	[e] 706	696	1.0:1	80,500	43,400	1.9:1
Diatomite	do	1,720	573	3.0:1	--	--	--	1,720	573	3.0:1
Feldspar	do	3,290	683	4.8:1	--	--	--	3,290	683	4.8:1
Fluorspar	do	68	22	1.8:1	525	118	4.2:1	593	140	3.8:1
Gypsum	do	21,600	7,700	1.1:1	2,160	2,050	1.0:1	23,800	9,750	1.1:1
Mica (scrap)	do	776	66	11.6:1	--	--	--	776	66	11.6:1
Perlite	do	726	511	1.4:1	--	--	--	726	511	1.4:1
Phosphate rock	do	402,000	48,500	7.9:1	W	W	W	402,000	48,500	7.9:1
Potassium salts	do	--	--	--	18,300	2,080	8.7:1	18,300	2,080	8.7:1
Pumice	do	4,010	3,890	1.0:1	--	--	--	4,010	3,890	1.0:1
Salt	do	566	196	2.9:1	15,100	13,800	1.1:1	15,600	14,000	1.1:1
Sand and gravel	do	789,000	789,000	1.0:1	--	--	--	789,000	789,000	1.0:1
Sodium carbonate (natural)	do	--	--	--	12,100	4,040	2.0:1	12,100	4,040	2.0:1
Stone:										
Crushed and broken	do	[e] 937,000	866,000	1.1:1	[e] 34,800	34,500	1.0:1	971,000	900,000	1.1:1
Dimension	do	[e] 3,500	1,040	3.4:1	42	42	1.0:1	3,540	1,080	3.3:1
Talc, soapstone, pyrophyllite	do	2,240	387	5.5:1	171	162	1.0:1	2,410	549	4.2:1

[e] Estimate. W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.

Table 12.—Mining methods used in open pit mining in 1975, by commodity

(Percent)

Commodity	Total material handled	
	Preceded by drilling and blasting	Not preceded by drilling and blasting [1]
METALS		
Bauxite	91	9
Copper	95	5
Gold:		
Lode	99	1
Placer	--	100
Iron ore	87	13
Lead	100	--
Manganiferous ore	100	--
Mercury	3	97
Molybdenum	100	--
Nickel	16	84
Platinum-group metals	--	100
Rare-earth metals	100	--
Silver	6	94
Tin	--	100
Titanium, ilmenite	11	89
Tungsten	15	85
Uranium	29	71
Vanadium	50	50
Zinc	100	--
NONMETALS		
Abrasive stone	100	--
Aplite	15	85
Asbestos	88	12
Barite	22	78
Boron minerals	100	--
Clays	--	100
Diatomite	--	100
Emery	100	--
Feldspar	94	6
Fluorspar	99	1
Garnet	20	80
Graphite	100	--
Greensand marl	--	100
Gypsum	84	16
Iron oxide pigments (crude)	--	100
Kyanite	55	45
Lithium minerals	100	--
Magnesite	100	--
Mica (scrap)	2	98
Millstones	98	2
Olivine	75	25
Perlite	1	99
Phosphate rock	6	94
Pumice	7	93
Salt	97	3
Sand and gravel	--	100
Stone:		
Crushed and broken	98	2
Dimension	--	100
Talc, soapstone, pyrophyllite	56	44
Tripoli	99	1
Vermiculite	54	46
Total	59	41

[1] Includes drilling or cutting without blasting, dredging, mechanical excavation and nonfloat washing, and other surface mining methods.

Table 13.—Exploration and development activity in the United States in 1975, by method

Method	Metals		Nonmetals		Total[1]	
	Feet	Percent of total[2]	Feet	Percent of total[2]	Feet	Percent of total[2]
DEVELOPMENT						
Shaft and winze sinking	22,100	2.5	2,080	0.4	24,200	1.8
Raising	125,000	14.1	2,790	.6	128,000	9.2
Drifting, crosscutting, tunneling	740,000	83.4	488,000	99.0	1,230,000	89.0
Total[1]	887,000	100.0	493,000	100.0	1,380,000	100.0
EXPLORATION						
Diamond drilling	2,360,000	9.8	187,000	32.6	2,550,000	10.4
Churn drilling	67,400	.3	--	--	67,400	.3
Rotary drilling	16,400,000	68.2	321,000	55.9	16,700,000	67.8
Percussion drilling	4,110,000	17.1	19,500	3.4	4,130,000	16.7
Other drilling	1,070,000	4.4	30,000	5.2	1,100,000	4.5
Trenching	56,200	.2	16,900	2.9	73,100	.3
Total[1]	24,100,000	100.0	574,000	100.0	24,600,000	100.0
Grand total[1]	24,900,000	--	1,070,000	--	26,000,000	--

[1] Data may not add to totals shown because of independent rounding.
[2] Based on unrounded footage.

Table 14.—Exploration and development in 1975, by method and selected metals and nonmetals
(Feet)

Commodity	Development				Exploration						
	Shaft and winze sinking	Raising	Drifting, cross-cutting or tunneling	Total [1]	Diamond drilling	Churn drilling	Rotary drilling	Percussion drilling	Other drilling	Trenching	Total [1]
METALS											
Copper	4,090	43,100	96,700	144,000	817,000	107	133,000	66,200	1,230	22,300	1,040,000
Gold	2,280	11,300	50,700	64,300	169,000	6,900	106,000	3,010,000	1,500	27,900	3,320,000
Iron ore	--	786	56,100	56,900	97,800	--	9,070	17,000	320	500	125,000
Lead	117	10,300	57,200	67,600	184,000	60,300	15,600	46,900	83,900	550	391,000
Mercury	--	--	18	18	--	--	--	--	--	--	--
Silver	3,590	10,400	27,600	41,600	45,900	--	17,400	65,400	60	3,280	132,000
Tungsten	52	3,570	4,510	8,140	16,400	--	8,550	1,600	--	375	26,900
Uranium	6,980	24,900	268,000	300,000	93,300	--	15,400,000	791,000	978,000	600	17,300,000
Zinc	2,920	15,600	103,000	122,000	725,000	--	120,000	107,000	1,900	--	954,000
Other [2]	2,070	4,910	75,900	82,900	216,000	96	566,000	4,650	1,270	600	789,000
Total [1]	22,100	125,000	740,000	887,000	2,360,000	67,400	16,400,000	4,110,000	1,070,000	56,200	24,100,000
NONMETALS											
Barite	--	--	--	--	--	--	2,500	14,200	20,800	5,200	42,800
Fluorspar	--	1,140	3,270	4,400	121,000	--	--	1,440	--	--	123,000
Gypsum	368	--	5,470	5,840	800	--	53,600	2,920	5,400	--	62,700
Phosphate rock	--	--	7,340	7,340	11,300	--	103,000	--	2,000	--	117,000
Potassium salts	--	--	20,000	20,000	22,100	--	34,200	--	--	--	56,300
Sodium carbonate (natural)	1,530	--	450,000	452,000	1,470	--	38,000	--	--	1,700	41,200
Talc, soapstone, pyrophyllite	180	1,450	1,620	3,250	--	--	7,640	--	--	--	7,640
Other [3]	--	200	400	600	30,400	--	81,400	880	1,780	10,000	124,000
Total [1]	2,080	2,790	488,000	493,000	187,000	--	321,000	19,500	30,000	16,900	574,000
Grand total [1]	24,200	128,000	1,230,000	1,380,000	2,550,000	67,400	16,700,000	4,130,000	1,100,000	73,100	24,600,000

[1] Data may not add to totals shown because of independent rounding.
[2] Bauxite, beryllium, columbium and tantalum, molybdenum, nickel, platinum-group metals, rare-earth metals, tin, and titanium (ilmenite).
[3] Boron minerals, bromine, clays, diatomite, lithium minerals, mica (scrap), millstones, salt, stone (crushed and broken), stone (dimension), and tripoli.

Table 15.—Exploration and development, in 1975, by method and State

(Feet)

State	Development				Exploration						
	Shaft and winze sinking	Raising	Drifting, cross-cutting, or tunneling	Total [1]	Diamond drilling	Churn drilling	Rotary drilling	Percussion drilling	Other drilling	Trenching	Total [1]
Alabama	--	--	--	--	--	--	426,000	--	--	--	426,000
Alaska	--	--	327	327	28,500	5,400	--	5,940	--	2,930	42,800
Arizona	617	41,900	85,800	128,000	236,000	107	150,000	29,100	3,830	3,080	422,000
Arkansas	--	--	--	--	--	--	65,200	--	--	--	65,200
California	308	3,880	7,290	11,500	65,000	1,500	137,000	16,800	1,040	675	222,000
Colorado	3,230	12,800	103,000	119,000	139,000	--	612,000	190,000	155,000	670	1,100,000
Florida	--	--	--	--	--	--	53,000	--	1,500	--	54,500
Georgia	--	--	--	--	11,700	--	64,100	--	--	--	75,700
Idaho	3,130	13,700	41,000	57,800	71,900	96	19,500	32,200	620	1,300	126,000
Illinois	--	1,140	3,270	4,400	121,000	--	--	--	--	--	121,000
Indiana	368	--	--	368	--	--	--	--	--	--	--
Iowa	--	--	--	--	--	--	--	--	5,400	--	5,400
Kansas	--	--	--	--	21,200	--	96,000	--	--	--	117,000
Kentucky	--	--	--	--	109,000	--	8,380	--	--	--	118,000
Maine	--	--	8,000	8,000	56,200	--	--	--	--	--	56,200
Michigan	1,490	--	6,580	8,070	57,400	--	10,400	--	--	--	67,800
Minnesota	--	--	--	--	85,300	--	1,610	5,360	--	--	92,300
Missouri	--	724	72,500	73,200	160,000	60,300	14,200	31,900	105,000	1,400	372,000
Montana	120	834	17,100	18,000	81,700	--	500,000	6,040	1,450	730	590,000
Nevada	860	300	2,890	4,050	131,000	--	148,000	75,300	320	43,900	399,000
New Hampshire	--	--	--	--	4,000	--	--	--	--	--	4,000
New Jersey	--	--	--	--	--	--	--	4,650	--	--	4,650
New Mexico	4,890	16,600	239,000	261,000	330,000	--	4,830,000	574,000	681,000	3,000	6,420,000
New York	--	8,950	38,600	47,500	76,200	--	--	--	--	--	76,200
North Carolina	--	--	--	--	10,100	--	--	--	--	--	10,100
Ohio	--	--	--	--	13,600	--	--	--	--	--	13,600
Oklahoma	--	--	--	--	--	--	18,100	--	--	10,000	28,100
Oregon	100	54	1,180	1,330	4,920	--	6,000	376	25	4,900	16,200
Pennsylvania	--	668	9,800	10,500	12,900	--	2,460	--	--	--	15,300
South Dakota	705	9,970	40,900	51,600	80,800	--	379,000	2,910,000	--	--	3,370,000
Tennessee	2,740	2,610	27,100	32,400	386,000	--	58,400	104,000	--	--	549,000
Texas	--	--	--	--	--	--	1,060,000	--	630	--	1,060,000
Utah	2,560	10,100	27,500	40,100	34,900	--	566,000	75,700	14,700	500	692,000
Vermont	180	--	--	180	--	--	--	--	--	--	--
Virginia	--	1,450	8,890	10,300	40,900	--	48,600	2,920	--	--	92,400
Washington	--	284	5,430	5,710	117,000	--	693,000	--	950	--	811,000
Wisconsin	--	--	1,850	1,850	54,100	--	9,600	100	--	--	63,800
Wyoming	2,900	1,550	480,000	484,000	10,500	--	6,730,000	64,400	127,000	--	6,940,000
Total [1]	24,200	128,000	1,230,000	1,380,000	2,550,000	67,400	16,700,000	4,130,000	1,100,000	73,100	24,600,000

[1] Data may not add to totals shown because of independent rounding.

Table 16.—Total material (ore and waste) produced by mine development in the United States in 1975, by commodity and State

(Thousand short tons)

	Shaft and winze sinking	Raising	Drifting, crosscutting, or tunneling	Stripping	Total [1]
COMMODITY					
METALS					
Copper	122	152	919	161,000	162,000
Gold:					
Lode	7	41	154	67	270
Placer	(2)	1	1	97	100
Iron ore	--	7	1,180	34,200	35,400
Lead	1	60	1,740	(2)	1,800
Silver	20	43	178	20	261
Tungsten	(2)	13	49	10	72
Uranium	82	81	1,050	74,900	76,100
Zinc	40	56	1,560	42	1,690
Other [3]	80	23	1,010	4,320	5,430
Total metals [1]	353	476	7,830	275,000	283,000
NONMETALS					
Fluorspar	--	7	26	29	62
Gypsum	6	--	168	13,100	13,300
Phosphate rock	--	--	18	19,800	19,800
Potassium salts	--	--	263	--	263
Pumice	--	--	--	75	75
Talc, soapstone, pyrophyllite	2	1	7	120	130
Other [4]	45	1	4,000	149	4,200
Total nonmetals [1]	53	9	4,480	33,300	37,800
Grand total [1]	405	485	12,300	308,000	321,000
STATE					
Alaska	--	--	1	95	97
Arizona	40	144	764	159,000	160,000
Arkansas	--	--	--	1,640	1,640
California	1	16	58	1,570	1,640
Colorado	89	60	1,340	147	1,530
Georgia	--	--	--	W	W
Idaho	20	72	305	11,700	12,100
Illinois	--	7	26	29	62
Indiana	W	--	--	--	W
Iowa	--	--	--	2,740	2,740
Louisiana	--	--	--	W	W
Maine	--	--	W	--	W
Michigan	27	--	197	19,100	19,400
Minnesota	--	--	--	16,800	16,800
Missouri	--	4	2,410	27	2,450
Montana	1	2	61	30	94
Nevada	1	2	7	1,690	1,700
New Mexico	43	38	1,010	1,540	2,630
New York	--	10	115	--	125
Ohio	--	--	--	W	W
Oklahoma	--	--	--	W	W
Oregon	(2)	(2)	6	(2)	7
Pennsylvania	--	W	W	W	W
South Dakota	W	W	W	--	W
Tennessee	37	15	979	24	1,060
Texas	--	--	--	18,400	18,400
Utah	63	65	233	8,850	9,210
Vermont	W	--	--	--	W
Virginia	--	3	182	36	220
Washington	--	1	131	735	867
Wisconsin	--	--	W	--	W
Wyoming	69	5	4,180	60,200	64,500
Undistributed	11	41	405	3,280	3,740
Total [1]	405	485	12,300	308,000	321,000

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.
[3] Bauxite, beryllium, mercury, molybdenum, platinum-group metals, and vanadium.
[4] Aplite, asbestos, barite, diatomite, mica (scrap), perlite, salt, and sodium carbonate (natural).

Table 17.—U.S. industrial consumption of explosives
(Thousand pounds)

Year	Coal mining	Metal mining	Quarrying and nonmetal mining	Total mineral industry	Other	Total industrial
1969	820,114	470,791	438,789	1,729,694	496,783	2,226,477
1970	962,331	479,508	455,424	1,897,263	496,228	2,393,491
1971	1,071,305	457,286	489,572	2,018,163	535,851	2,554,014
1972	1,212,585	430,686	493,677	2,136,948	532,841	2,669,789
1973	1,177,062	495,879	643,292	2,316,233	438,713	2,754,946
1974	1,186,614	465,490	551,380	2,203,484	558,806	2,762,290
1975	1,652,251	449,271	493,125	2,594,647	524,380	3,119,027

Table 18.—Industrial explosives and blasting agents sold for consumption in the United States, 1912–75 [1]

(Thousand pounds)

Year	Permissibles	Other high explosives	Water gels and slurries	Cylindrically packaged blasting agents	Other processed blasting agents and unprocessed ammonium nitrate	Black blasting powder	Liquid oxygen	Total [1]
1912	24,630	234,469	--	--	--	230,293	--	489,393
1913	27,686	242,387	--	--	--	229,940	--	500,012
1914	25,698	218,454	--	--	--	206,100	--	450,251
1915	27,350	235,829	--	--	--	197,722	--	460,901
1916	34,685	255,155	--	--	--	215,575	--	505,415
1917	43,041	262,316	--	--	--	277,119	--	582,475
1918	46,045	206,416	--	--	--	246,663	--	449,125
1919	38,855	198,269	--	--	--	180,511	--	417,634
1920	53,963	229,112	--	--	--	254,880	--	537,955
1921	41,134	170,952	--	--	--	160,021	--	372,108
1922	43,430	209,476	--	--	--	178,866	--	431,772
1923	60,371	267,405	--	--	--	201,951	--	529,728
1924	55,134	273,323	--	--	--	167,076	--	495,533
1925	58,353	286,435	--	--	--	156,964	--	501,752
1926	67,685	310,518	--	--	--	157,687	--	535,890
1927	63,847	303,468	--	--	--	131,696	--	499,011
1928	60,708	292,785	--	--	--	121,758	--	475,251
1929	62,669	326,993	--	--	--	120,046	--	509,708
1930	53,826	291,391	--	--	--	99,873	--	445,090
1931	41,578	216,157	--	--	--	79,830	--	337,565
1932	32,225	137,908	--	--	--	63,755	--	233,887
1933	33,927	157,849	--	--	--	64,211	--	255,987
1934	39,208	206,625	--	--	--	68,935	--	314,768
1935	39,170	200,324	--	--	--	68,888	--	308,381
1936	47,859	262,047	--	--	--	81,698	--	391,604
1937	49,579	288,924	--	--	--	66,241	--	404,744
1938	41,859	238,576	--	--	--	51,695	--	332,130
1939	49,950	278,250	--	--	--	58,237	--	386,438
1940	58,436	305,180	--	--	--	59,753	--	423,369
1941	70,612	351,857	--	--	--	59,458	--	481,927
1942	84,022	359,699	--	--	--	55,534	--	499,255
1943	92,656	338,573	--	--	--	46,422	--	477,651
1944	102,538	318,613	--	--	--	42,960	--	464,111
1945	97,407	322,956	--	--	--	36,948	--	457,311
1946	100,258	399,233	--	--	--	36,824	--	536,315
1947	122,349	476,017	--	--	--	36,464	16,562	651,391
1948	126,282	550,086	--	--	--	33,240	15,620	725,227
1949	91,630	505,601	--	--	--	20,077	13,922	631,230
1950	109,420	575,962	--	--	--	20,655	13,804	719,841
1951	108,258	611,236	--	--	--	13,985	20,341	753,821
1952	95,460	636,741	--	--	--	10,602	21,915	764,718
1953	89,879	668,952	--	--	--	9,515	22,465	790,811
1954	75,863	615,822	--	--	--	10,298	17,741	719,724
1955	93,718	687,226	--	--	--	6,624	19,310	806,878
1956	104,934	898,524	--	--	--	5,593	17,723	1,026,774
1957	104,522	912,589	--	--	--	3,684	13,835	1,034,631
1958	84,085	864,117	--	--	--	2,492	10,904	961,597
1959	83,520	479,015	--	--	476,901	2,333	6,808	1,048,576
1960	80,577	472,266	--	--	616,950	1,537	1,668	1,172,998
1961	73,439	460,224	--	--	666,202	1,521	2,235	1,203,621
1962	72,884	436,991	--	--	799,066	1,222	2,243	1,312,406
1963	76,319	422,779	--	--	953,854	1,138	1,834	1,455,924
1964	77,406	481,451	--	--	1,103,563	946	2,184	1,665,551
1965	76,040	542,318	--	--	1,260,108	836	5,598	1,884,900
1966	74,527	538,968	--	--	1,343,104	463	13,094	1,970,156
1967	68,770	304,566	167,018	66,413	1,287,506	424	10,017	1,904,714
1968	64,130	288,114	206,518	40,732	1,347,817	427	--	1,947,737
1969	60,364	286,464	221,535	33,281	1,624,564	270	--	2,226,477
1970	56,269	285,841	214,856	37,430	1,799,012	83	--	2,393,491
1971	43,557	272,816	230,692	42,967	1,963,865	117	--	2,554,014
1972	46,147	268,798	226,243	266,206	1,862,395	--	--	2,669,789
1973	44,272	262,445	263,545	278,658	1,906,026	--	--	2,754,946
1974	42,331	257,735	293,248	301,261	1,867,715	--	--	2,762,290
1975	46,422	225,318	311,132	331,725	2,204,430	--	--	3,119,027

[1] Data may not add to totals shown because of independent rounding.

Source: Bureau of Mines Mineral Industry Surveys, Explosives Annual, Apr. 21, 1976.

Table 19.—U.S. consumption of explosives in the minerals industry
(Thousand pounds)

Year	Coal mining	Metal mining	Quarrying and nonmetal mining	Total
PERMISSIBLE EXPLOSIVES				
1972	42,232	99	865	43,196
1973	39,307	115	957	40,379
1974	38,332	192	1,237	39,761
1975	41,996	241	1,083	43,320
OTHER HIGH EXPLOSIVES				
1972	16,297	27,648	100,600	144,545
1973	20,198	28,295	107,675	156,168
1974	26,301	27,733	99,364	153,398
1975	36,875	25,118	74,796	136,789
CYLINDRICALLY PACKED BLASTING AGENTS				
1972	201,820	7,542	30,064	239,426
1973	222,797	6,265	32,228	261,290
1974	249,843	5,414	32,797	288,054
1975	286,608	4,845	28,551	320,004
WATER GELS AND SLURRIES				
1972	9,212	156,618	41,305	207,135
1973	11,622	173,530	54,154	239,306
1974	22,204	160,198	75,837	258,239
1975	24,118	181,809	73,872	279,799
OTHER PROCESSED BLASTING AGENTS AND UNPROCESSED AMMONIUM NITRATE				
1972	943,024	238,779	320,843	1,502,646
1973	883,138	287,674	448,278	1,619,090
1974	849,934	271,953	342,145	1,464,032
1975	1,262,654	237,258	314,823	1,814,735
TOTAL EXPLOSIVES				
1972	1,212,585	430,686	493,677	2,136,948
1973	1,177,062	495,879	643,292	2,316,233
1974	1,186,614	465,490	551,380	2,203,484
1975	1,652,251	449,271	493,125	2,594,647

FLOTATION TRENDS [2]

During the past 5 years, the greatest emphasis in froth flotation continued to be directed toward the design and development of new flotation machines and improvements in existing ones. One reason for changes concerns mixing efficiency. Studies have revealed that air and solids impair mixing, thus leading to the development of flotation machines in which the flow pattern in the tank includes the recirculation of a large portion of the pulp in the impeller region. Other machines being developed are of the countercurrent type with deep cells and mechanical dispersers. A machine of this design was recently developed in the Soviet Union; it not only requires less maintenance but also uses one-fifth less electrical energy than conventional cells.

A second area of effort is in the search for new reagents. Although some 300 types of commercial flotation reagents are available, research to replace expensive reagents by cheaper ones continues. Research is also being conducted to develop reagents that have high selectivity.

Another area of flotation processing receiving attention is that of automation. Plants utilizing up-to-date measuring and controlling devices are on the increase. X-ray analysis and computer control are the main methods being employed. Although the instruments needed are costly, pulp consistency measurements allow for better quality control and higher recoveries. Accurate and reliable measurement of reagent feeding is also important in the flotation process. Automatic control is, therefore, of primary concern.

In the future, beneficiation by flotation will require more sophisticated reagents, machines, and control systems in order to treat ever-increasing tonnages, especially as it becomes necessary to utilize ores from lower grade deposits.

Every 5 years the Bureau of Mines conducts a survey of flotation plants in the United States in order to determine trends in this small but important industry. The growth of froth flotation in the minerals industry of the United States during the last 15 years has been determined by comparing data collected for 1960, 1965, 1970, and 1975.

The 252 flotation plants reported operating in 1975 represented a 30% increase over the 194 reporting in 1960. However, the combined daily capacity, 1,612,000 tons, of the plants in 1975 was more than double the 730,000 tons of 1960.

Significant gains were registered in quantity of material treated and in production of concentrates. In 1975, the nearly 423 million tons of ore treated was more than double the 198 million tons processed in 1960. The production of 60.3 million tons of concentrate in 1975 was nearly three times the 21.5 million tons produced in 1960.

Of the total ore treated by flotation in 1975, 66% was metal sulfides, 7% metal oxides and carbonates, 24% nonmetallic minerals, and 3% solid mineral fuels. Comparable data for 1960 showed that metal sulfides accounted for 78%, metal oxides and carbonates 2%, nonmetallic minerals 18%, and solid mineral fuels 2%.

About 30 mineral-bearing materials were treated by flotation in 1975, led by the ores of copper, copper-molybdenum, iron, molybdenum, phosphate rock, potash, and coal. Since 1960 the largest growth rates were reported for flotation of iron ore, phosphate rock, and coal.

Although the consumption of 1,769 million pounds of flotation reagents in 1975 was double that of 1960—corresponding to the growth in quantity of material treated by flotation—the value of the reagents consumed rose fourfold to $87.7 million in 1975.

Significant trends that continued or emerged in froth flotation included the continued treatment of large and increasing quantities of copper and copper-molybdenum ores, the continued decline in grade of copper-bearing ores, the continued rapid growth in flotation of iron ore, phosphate rock, and bituminous coal, and the emerging spiraling costs of flotation reagents.

Consumption of Energy, Water, and Grinding Media, Including Mill Liners.— Energy consumption in kilowatt-hours per ton of ore processed at flotation plants remained relatively constant during 1960–75, averaging 16.2 in 1960, 15.4 in 1965, 15.3 in 1970, and 15.8 in 1975. However, the increase in quantity of ore treated at

[2] Prepared by Gertrude Greenspoon, mineral specialist, Division of Nonferrous Metals, and John L. Morning, supervisory physical scientist, Division of Ferrous Metals.

flotation plants resulted in a corresponding increase in total energy consumption, which rose from 3,210 million kilowatt-hours in 1960 to 6,541 million kilowatt-hours in 1975. Total energy consumption includes all energy used in the various processes inherent to the flotation plant, such as crushing, grinding, classifying, flotation, filtering, and material handling.

The average quantity of water used per ton of ore processed in the flotation plants rose slightly, from 1,140 gallons in 1960 to 1,270 gallons in 1975. Again, corresponding to the increase in quantity of material treated, water used at flotation plants increased from 222 billion gallons in 1960 to more than 527 billion gallons in 1975. Total water quantities are reported, including both recirculated and new or makeup water.

Data on the use of grinding media in flotation plants have been available only since 1965. Generally, the total quantities used increased in proportion to the quantity of ore treated. For example, during 1965–75, rod consumption rose from 50.3 million pounds to 72.6 million pounds, ball consumption increased from 201.7 million pounds to 405.9 million pounds, and liner consumption went from 16.9 million pounds to 36.2 million pounds. Corresponding use of grinding media in pounds per ton of ore treated in 1965 and in 1975 follows: Rods, 0.55 and 0.46; balls, 1.09 and 1.31; and liners, 0.14 and 0.12.

Consumption of Reagents.—Reflecting the twofold increase in quantity of ore treated, the total consumption of flotation reagents also doubled, rising from slightly more than 850 million pounds in 1960 to nearly 1,769 million pounds in 1975. At the same time, the average consumption of reagents per ton of ore treated remained relatively constant, 4.3 pounds in 1960, 4.5 pounds in 1965, 5.1 pounds in 1970, and 4.2 pounds in 1975. Except for minor variations, the use of reagents per ton of ore treated fell for modifiers, collectors, frothers, and flocculants, remained about the same for activators, and rose for depressants.

Value of reagents consumed totaled $21.8 million in 1960, $31.0 million in 1965, $50.9 million in 1970, and $87.7 million in 1975. Concurrently, the average cost of reagents per ton of ore treated was $0.11 in 1960 and in 1965, $0.13 in 1970, and $0.21 in 1975.

The following classification of reagents is used in this report:

Modifiers.—Reagents used to control alkalinity and to eliminate harmful effects of colloidal material and soluble salts.

Activators.—Reagents used to assist or improve the flotation of minerals that do not respond to a simple collector-froth combination.

Depressants.—Reagents used to improve the selective separation of minerals by lowering the floatability of specific minerals.

Collectors.—Reagents used to provide a water-repellent surface on the mineral to be floated so as to improve adherence of the mineral to air bubbles.

Frothers.—Reagents used to produce a froth of adequate durability to permit removal of mineral-carrying bubbles from the flotation machine.

Flocculants.—Reagents used to flocculate solids in aqueous suspension and thereby facilitate thickening and filtering operations.

Also, to avoid disclosing confidential information, some reagents are not identified but are included under "other," or information on two or more reagents is combined.

Distribution of Flotation Plants.—The 252 flotation plants operating in 1975 were located in 35 States. West Virginia led with 34 plants, followed by Arizona (21), Florida (19), Pennsylvania and Virginia (16 each), New Mexico (15), Colorado (14), and North Carolina (12). Those plants in West Virginia, Virginia, and Pennsylvania were principally processors of coal; those in Arizona, copper and copper-molybdenum ores; those in Florida, phosphate rock; those in New Mexico, copper and other base metal ores; and those in North Carolina, feldspar, mica, quartz, and spodumene.

Changes in Types of Material Treated.—To help detect any changes that occur in the types of material treated, kinds and quantities of product recovered, and reagents consumed, data were compiled by classifying materials with similar characteristics into one of four groups. The groups consist of sulfide ores, metallic oxides and carbonates, nonmetallic ores, and solid mineral fuels. Data were also compiled in greater detail for selected individual mineral commodities.

Sulfide Ores.—The principal sulfide ores treated by flotation were those of copper and copper-molybdenum. In 1975, these ores accounted for 85% of the total ores treated in sulfide flotation plants.

Although the number of flotation plants treating sulfide ores ranged from 95 in 1960, 108 in 1965, 105 in 1970, and 86 in 1975, the total daily capacity of the plants rose 81% from 1960 to 1975. The quantity of sulfide ores treated by flotation increased 79% during this period. However, production of sulfide flotation concentrates increased only 26% because of lower grade ores treated.

Sulfide ore represented 66% of the total ore treated by flotation in 1975, compared with 71% in 1970, 72% in 1965, and 78% in 1960. Also, sulfide concentrate produced represented 12% of total flotation concentrate recovered in 1975, compared with 16% in 1970, 19% in 1965, and 27% in 1960. Although the quantity of sulfide ore treated by flotation continued to gain, the flotation of nonsulfide materials have registered an even higher growth rate during 1960–75.

Because of the continued decline in grade of copper-bearing ores, the ratio of concentration of sulfide ores has shown a steady increase, rising from 26.5 to 1 in 1960, to 27.8 to 1 in 1965, to 31.8 to 1 in 1970, and to 37.6 to 1 in 1975. Average flotation reagent consumption per ton of ore treated rose slightly from 3.5 pounds in 1960 to 4.3 pounds in 1975.

Metal Oxides and Carbonates.—Flotation of iron oxide minerals dominates the flotation operations for this group of minerals which also includes ilmenite, limestone, and tungsten. For example, in 1975, iron oxide ore represented nearly 95% of the total ore treated, and accounted for over 95% of the total concentrates produced by flotation of metal oxides and carbonates.

The number of flotation plants (13) in 1975 was the same as in 1960. However, because of expansions in iron ore flotation, the total daily capacity of the plants rose from 14,000 tons in 1960 to 90,000 tons in 1975. Concurrently, the quantity of ore treated increased more than 10 times—from about 2.9 million tons in 1960 to 30.1 million tons in 1975—and concentrate production increased from less than 1 million tons in 1960 to more than 15 million tons in 1975.

Metal oxides and carbonate ores represented 7% of the total ores treated by flotation in 1975, compared with about 6% in each of 1970 and 1965, and slightly over 1% in 1960. Concentrate recovered accounted for 26% of total concentrates produced in 1975, compared with 24% in 1970, 18% in 1965, and 4% in 1960.

In 1970 and 1975, the material treated included magnetic iron concentrates that were upgraded by flotation; hence the drop in ratio of concentration from 3.0 to 1 in 1960 to 1.7 to 1 in 1970. On the other hand, the rise in ratio of concentration from 1.7 to 1 in 1970 to 1.9 to 1 in 1975 probably was due to the installation of a new large flotation plant in 1974 for treating nonmagnetic iron ores.

Although average reagent consumption per ton of ore treated was abnormally high in 1960, primarily because of two flotation plants that later ceased operations, average reagent consumption per ton of ore treated showed only minor fluctuations between 2.6 pounds in 1965, 2.2 pounds in 1970, and 2.8 pounds in 1975.

Nonmetallic Ores.—The number of flotation plants treating nonmetallic ores increased about 36% from 55 in 1960 to 75 in 1975. At the same time, the total daily capacity more than tripled, and the quantity of ore treated and concentrates produced each rose nearly threefold.

Phosphate continued as the leader in nonmetallic ore flotation and, in 1975, accounted for 74% of the nonmetallic ore treated by flotation and for 62% of the nonmetallic flotation concentrate produced. Significant quantities of potash, glass sand, and feldspar were also processed by flotation.

The quantity of nonmetallic ore treated by flotation represented 24% of the total ore treated by flotation in 1975, compared with 20% in 1970, 19% in 1965, and 18% in 1960. Nonmetallic mineral concentrate produced was 48% of total concentrate recovered in 1975, compared with 44% in 1970, 45% in 1965, and 55% in 1960.

Average reagent consumption per ton of ore treated totaled 4.7 pounds in 1975, compared with 8.7 pounds in 1970, 5.1 pounds in 1965, and 7.3 pounds in 1960.

Solid Mineral Fuels.—As a result of the rapid growth in flotation of bituminous coal, the number of flotation plants treating solid mineral fuels rose from 31 in 1960 to 78 in 1975. During the period the number of anthracite flotation plants decreased by 40% whereas the number of bituminous coal flotation plants nearly tripled. Corresponding increases of approximately threefold occurred in the total daily capacity, in the quantity of material treated, and in the production of clean coal.

Solid mineral fuels accounted for 3% of the total material treated by flotation in 1975, the same as in 1970 and 1965 but 1% higher than in 1960. Clean coal produced in 1975 represented 14% of the total material recovered by flotation, compared with 16% in 1970, 18% in 1965, and 13% in 1960.

Decreased usage of modifiers, collectors, and flocculants at solid mineral fuels flotation plants caused the average consumption of flotation reagents per ton of material treated to fall to 0.7 pound in 1975, compared with 1.2 pounds in 1970, 0.9 pound in 1965, and 2.6 pounds in 1960.

Copper.—One of the outstanding features of domestic copper flotation operations during 1960–75 was the impressive growth in both the productive capacity and the quantity of ore treated each year. Although the number of flotation plants (18) operating in 1975 was the same as in 1960, the total rated daily capacity more than doubled, rising from 158,000 tons in 1960 to 323,000 tons in 1975. The quantity of copper ore concentrated also more than doubled, increasing from 44 million tons in 1960 to 92 million tons in 1975.

The production of copper concentrate increased at a slower rate and rose only about 40% during 1960–75. The persistent drop in average grade of ore treated, from 0.92% copper in 1960 to 0.75% in 1975, more than offset improvements in processing procedures and reagent effectiveness.

The average consumption of flotation reagents per ton of copper ore treated rose from 2.5 pounds in 1960 to 8.2 pounds in 1970 and then dropped to 6.5 pounds in 1975, and the cost of the reagents per ton of ore increased from $0.06 in 1960 to $0.16 in 1975.

The location of copper flotation plants in 1975 was similar to that of preceding years with eight in Arizona, four in New Mexico, three in Nevada, two in Montana, and one in Michigan.

Copper–Molybdenum. — Although the number of flotation plants concentrating copper-molybdenum ore rose 50%—from 10 in 1960 to 15 in 1975—the rated daily capacity of the plants increased almost 100%, from 263,000 tons in 1960 to 514,000 tons in 1975. The 145 million tons of copper-molybdenum ore concentrated in 1975 was about 7% less than that treated in 1970 but exceeded that treated in 1960 by 53%.

Despite a relatively steady average copper recovery of 84% during 1960–75, the drop in average copper content of the ore from 0.69% in 1960 to 0.53% in 1975 limited the growth in output of copper concentrate to about 20% during the interval. Conversely, output of molybdenum concentrate increased about 80% from nearly 17,000 tons in 1960 to more than 30,000 tons in 1975.

The average consumption of flotation reagents per ton of ore treated declined from 4.5 pounds in 1960 to 3.5 pounds in 1975. At the same time the average cost of reagents per ton of ore treated rose from $0.06 to $0.11.

As in other years, the flotation plants that treated copper-molybdenum ores in 1975 were located in only 4 States, with 11 in Arizona, 2 in Utah, 1 in Nevada, and 1 in New Mexico.

Copper-Lead-Zinc. — The predominant feature of copper-lead-zinc ore flotation during 1960–75 was the enormous growth in lead concentrate production. Despite a decrease in number of flotation plants from 19 in 1960 to 13 in 1975 and only a minor increase in total plant capacity from 26,000 tons per day in 1960 to 29,000 tons per day in 1975, output of lead concentrate jumped from 103,000 tons in 1960 to 409,000 tons in 1975.

An increase in average grade of ore treated from 2.07% lead in 1960 to 4.91% lead in 1975 and a 30% increase in annual quantity of ore treated, were the principal factors contributing to the growth in lead concentrate production.

Concurrently, the average grade of copper in the ore treated declined from 0.98% to 0.29% and that of zinc dropped slightly from 1.08% in 1960 to 0.99% in 1975. As a result, output of copper concentrate in 1975 was about 25% that of 1960, whereas production of zinc concentrate in 1975 was about three times that of 1960.

With minor fluctuations, consumption of flotation reagents rose from 1.7 pounds per ton of ore in 1960 to 2.1 pounds per ton in 1975. Flotation reagents costs, however, increased steadily, from $0.10 per ton in 1960 to $0.25 per ton in 1975.

The location of flotation plants in 1975 was little changed from previous years with five in Missouri, three in Colorado, three in Idaho, one in Maine, and one in New Mexico.

Copper-Zinc-Iron Sulfide. — Virtually every component of copper-zinc-iron sulfide ore flotation declined from 1960 to 1975. The number of flotation plants decreased from eight in 1960 to three in 1975, with a drop in total daily capacity from 10,000 tons to 8,500 tons. Ore treated increased from 2.4 million tons in 1960 to 3.3 million tons in 1965 and then fell to 2.0 million tons in 1975.

With relatively minor fluctuations, the production of concentrates also dropped during 1960–75. Output of copper concentrate decreased from 91,000 tons in 1960 to 84,000 tons in 1975, zinc concentrate output went from 46,000 tons to 28,000 tons, and iron sulfide concentrate production fell from 863,000 tons in 1960 to 698,000 tons in 1975.

From 1960 to 1975, the average grade of ore treated declined from 1.03% to 0.91% for copper, declined from 41.20% to 31.90% for iron sulfide, and except for small variations in 1965 and 1970 was unchanged for zinc at 1.42%.

Gains were registered both in quantity and value of reagents per ton of ore. Reagent consumption rose from 8.5 pounds per ton of ore in 1960 to 14.7 pounds per ton of ore in 1975. At the same time the value of reagents per ton of ore rose from $0.18 to $0.60.

In 1975, one each of the copper-zinc-iron sulfide flotation plants was located in Arizona, Pennsylvania, and Tennessee.

Gold-Silver.—The magnitude of gold-silver ore flotation remained relatively small with a general downward trend from 1960 to 1975. The number of plants decreased from four in 1960 to three in 1975, and total daily capacity fell 48% from 1,600 tons per day to 890 tons per day. Similarly, the quantity of ore treated also decreased 50%, from 132,000 tons in 1960 to 66,000 tons in 1975.

The general decline in average grade of ore from 0.99 ounce of gold and 4.33 ounces of silver per ton in 1960 to 0.40 ounce of gold and 2.40 ounces of silver per ton in 1975 resulted in a decrease in concentrate production from 3,360 tons in 1960 to 476 tons in 1975.

Average consumption of flotation reagents varied slightly from 0.40 pound per ton of ore in 1960 to 0.46 pound per ton of ore in 1975, but average cost of reagents per ton of ore increased from $0.14 in 1960 to $0.35 in 1975.

In 1975, there was one gold-silver flotation plant each in California, Colorado, and Washington.

Lead-Zinc.—The flotation of lead-zinc ores registered remarkable gains from 1960 to 1975. Despite a drop in number of plants from 28 to 21 and a decrease in total daily capacity from 39,000 to 31,000 tons, the quantity of lead-zinc ore treated by flotation rose from 6.0 million tons in 1960 to 7.5 million tons in 1975.

The average lead content of the ore trended upward from 2.37% in 1960 to 4.78% in 1975, whereas that of zinc declined from 4.81% to 4.06%. Consequently, lead concentrate production increased steadily from 200,000 tons in 1960 to 476,000 tons in 1975, and zinc concentrate output rose at a slower rate from 460,000 tons in 1960 to 477,000 tons in 1975.

Average consumption of flotation reagents remained fairly stable—2.6 pounds per ton of ore in 1960 compared with 2.7 pounds per ton in 1975. However, the average cost of reagents per ton of ore increased from $0.21 in 1960 to $0.50 in 1975.

The location of the lead-zinc flotation plants in 1975 was similar to that of previous years with six in Colorado, five in Idaho, two in Missouri, two in Utah, and one each in Arizona, California, New Mexico, New York, Virginia, and Washington.

Zinc.—Although the number of zinc flotation plants fluctuated between 7 in 1960 and 10 in 1975, the productive capacity of the plants increased steadily from 14,000 tons per day in 1960 to nearly 20,000 tons per day in 1975.

The quantity of zinc ore concentrated by flotation trended upward from 2.6 million tons in 1960 to nearly 3.8 million tons in 1970 but dropped to 3.1 million tons in 1975. Even though the average recovery of zinc in concentrate remained relatively constant at about 93%, the decrease in average grade of ore from 5.91% zinc in 1960 to 4.38% zinc in 1975 caused the output of zinc concentrate to drop from 233,000 tons in 1960 to about 212,000 tons in 1975.

Despite a continual decrease in average consumption of flotation reagents per ton of ore treated, from 1.1 pounds in 1960 to 0.8 pound in 1975, the average cost of reagents per ton of ore increased from $0.13 to $0.18 during the 1960–75 period.

In 1975, the location of the zinc flotation plants was similar to that of the preceding years with six in Tennessee, two in Wisconsin, and one each in New York and Pennsylvania.

Fluorspar.—All phases of fluorspar ore flotation trended downward between 1960 and 1975. The number of flotation plants in 1960 decreased 50% to three in 1975, the total daily capacity of the plants was reduced by one-third to 1,400 tons, and the quantity of ore treated decreased more than 40% to 275,000 tons in 1975.

At the same time, the production of fluorspar concentrate and byproduct lead and zinc concentrates each fell about 50% from 1960 to 75,000 tons of fluorspar, 1,500 tons of lead, and 9,000 tons of zinc in 1975. Average grade of ore declined from 41% fluorspar in 1960 to 38% in 1975.

During the 1960–75 period, the average consumption of flotation reagents per ton of ore nearly tripled, from 7.0 pounds in 1960 to 19.4 pounds in 1975, as did the average cost per ton, which rose from $0.75 to $2.07.

Illinois with two flotation plants and Kentucky with one plant were the sole fluorspar producers in 1975.

Feldspar, Mica, Quartz, and Spodumene.—Significant gains were recorded in the flotation of this group of minerals in 1960–75. The number of flotation plants increased 30% to 13 in 1975, the total daily capacity of the plants nearly doubled to 10,400 tons in 1975, and the quantity of ore treated more than doubled, from 1.0 million tons in 1960 to 2.6 million tons in 1975.

Notable corresponding gains were also registered in production of concentrates. From 1960 to 1975, feldspar concentrate output rose from 276,000 tons to 531,000 tons, mica concentrate output went from 24,000 to 93,000 tons, quartz concentrate production increased from about 70,000 tons to 295,000 tons, and output of other concentrates, mainly spodumene, rose from 17,000 tons to 218,000 tons.

Flotation reagent consumption per ton of ore declined from 9.2 pounds in 1960 to 3.3 pounds in 1975, and contrary to other flotation operations, reagent costs per ton of ore also declined from $0.67 in 1960 to $0.58 in 1975.

North Carolina with nine flotation plants continued as the leading State, followed by Alabama, Connecticut, Georgia, and Ohio with one plant each.

Glass Sand.—The large growth reported in glass sand flotation between 1960 and 1975 was probably due in part to more complete coverage of the industry by the Bureau of Mines flotation survey. However, it is noteworthy that the number of plants increased from 5 in 1960 to 22 in 1975. Equally striking was the growth in total daily plant capacity from 3,000 tons in 1960 to 40,000 tons in 1975, the rise in quantity of material treated from 800,000 tons in 1960 to about 7.4 million tons in 1975, and the increase in production of clean sand from 735,000 tons in 1960 to almost 6.1 million tons in 1975.

Flotation reagent consumption averaged 2.2 pounds per ton of material treated in 1975—down slightly from 2.4 pounds per ton in 1960. Average reagent costs of $0.21 per ton of material treated in 1960 remained relatively constant until 1975, when they rose to $0.34 per ton.

In 1975, the glass sand flotation plants were located in several States as follows: California four, Florida two, Georgia one, Idaho one, Louisiana one, Michigan two, New Jersey three, North Carolina one, Oklahoma one, Pennsylvania two, South Carolina one, Tennessee two, and West Virginia one.

Iron Ore.—Of all the flotation operations, the greatest advancement and growth occurred in the flotation of iron ore during 1960–75. A leading contributor to that advancement and growth was the Bureau of Mines, which, in cooperation with industry, pioneered and developed a flotation procedure for efficiently concentrating nonmagnetic iron ores. A plant using the Bureau process was placed in operation in 1974.

Although the number of flotation plants treating iron ore increased only from four in 1960 to five in 1975, Bureau developments and other improvements in iron ore flotation caused total daily capacity of the plants to increase from 6,000 tons in 1960 to 83,000 tons in 1975.

The quantity of ore treated and the quantity of concentrate produced each year showed similar and rapid growth. For example, ore treated rose from 1.5 million tons in 1960 to 28.6 million tons in 1975. Concurrently, concentrate output jumped from about 600,000 tons in 1960 to nearly 15 million tons in 1975. In 1970 and 1975, the ore treated included magnetic concentrate that was upgraded by flotation.

The average consumption of flotation reagents per ton of ore treated fell from 5.3 pounds in 1960 to 2.6 pounds in 1975, whereas the corresponding costs of reagents rose from $0.28 in 1960 to $0.38 in 1975.

In 1975, four iron ore flotation plants were in Michigan; the other plant was in Missouri.

Limestone-Magnesite. — The seemingly erratic behavior of the domestic limestone-magnesite flotation operations between 1960 and 1975 may have resulted from inadequate coverage in conducting surveys of the operations. The number of flotation plants ranged from three in 1960 to five in 1975. During the interval, total daily plant capacity rose from 1,000 tons in 1960 to 4,600 tons in 1970 and then dropped to 2,000 tons in 1975. Material treated in the flotation plants increased from 218,000 in 1960 to 1.1 million tons in 1970 and subsequently decreased to 402,000 tons in 1975.

Concentrate production followed a similar pattern, rising from 105,000 tons in 1960 to 864,000 tons in 1970 and falling to 341,000 tons in 1975. Average flotation reagent consumption per ton of material treated showed a relatively general increase from 2.8 pounds in 1960 to 5.1 pounds in 1975. Average cost of flotation reagents per ton of material treated rose with minor fluctuations from $0.35 in 1960 to $0.74 in 1975.

Two of the five limestone-magnesite flotation plants operating in 1975 were in Vermont, and Maryland, Nevada, and Texas had one each.

Phosphate.—The flotation of phosphate ores registered remarkable growth during 1960–75. Although the number of flotation plants for treating phosphate ores increased from 15 in 1960 to 19 in 1975, the total daily plant capacity increased fourfold, rising from 89,000 tons in 1960 to 356,000 tons in 1975, and quantity of material treated increased nearly fourfold from 21 million tons in 1960 to 75 million tons in 1975.

Because of a decline in average grade of material treated from 13.8% P_2O_5 in 1960 to 11.6% P_2O_5 in 1975, the growth in flotation concentrate production lagged behind that of the material treated and rose nearly threefold—from 7.0 million tons in 1960 to 18.4 million tons in 1975.

Flotation reagent consumption varied widely and ranged from 11.1 pounds per ton of material treated in 1960 to 5.6 pounds per ton of material treated in 1975. Flotation reagent cost per ton of material treated also fluctuated, but to a lesser degree, and rose from $0.20 in 1960 to $0.33 in 1975.

In 1975, most of the phosphate flotation plants (17) were in Florida with one each in North Carolina and Utah.

Potash.—Flotation of potash ores showed minor but important growth between 1960 and 1975. In 1960, there were seven flotation plants with a total daily capacity of 40,000 tons, compared with eight plants with a total daily capacity of 49,000 tons in 1975. Fluctuations in the annual quantity of material treated were varied, however; the 13.9 million tons treated in 1975 exceeded that of 1960 by almost 2 million tons.

The declining average grade of ore from 18.5% K_2O in 1960 to 16.4% in 1975 retarded the growth in output of potash concentrate, which rose from 3.1 million tons in 1960 to only 3.4 million tons in 1975.

Flotation reagent consumption per ton of material treated dropped slightly from 1.1 pounds in 1960 to 0.9 pounds in 1975. Conversely, the cost of reagents per ton of material treated rose slightly from $0.17 in 1960 to $0.20 in 1975.

In 1975, as in previous years, the flotation plants were located in only two States—six in New Mexico and two in Utah.

Anthracite and Bituminous Coal.—Only three anthracite flotation plants operated in 1975. Therefore, data on the operations have been combined with similar data on bituminous coal flotation to avoid disclosing confidential information of the anthracite processors. From 1960 to 1975, the number of anthracite flotation plants—all in Pennsylvania—dropped from five to three, and the total daily capacity of the plants, the annual quantity of material treated, and the annual production of clean anthracite produced each fell about 80%.

Conversely, during 1960–75, the number of bituminous coal flotation plants nearly tripled from 26 in 1960 to 75 in 1975. At the same time, the quantity of coal treated and the quantity of clean coal produced each rose almost fourfold.

Flotation reagent consumption per ton of bituminous coal treated fell with slight annual variations from 2.7 pounds in 1960 to 0.7 pound in 1975. However, average costs of reagents per ton of coal doubled, rising from $0.09 in 1960 to $0.18 in 1975.

West Virginia continued as the leader in bituminous coal flotation plants in 1975 with 33 plants, followed by Virginia 13, Pennsylvania 9, Alabama 5, Illinois and Kentucky, 4 each, Colorado 3, Utah 2, and Indiana and New Mexico 1 each.

Miscellaneous.—Data from some flotation operations are not shown separately to avoid disclosing company confidential information. Also, because of dissimilarity of data for various plants, it would be inappropriate to combine the data. However, the data have been included in the totals to present complete information on flotation in the minerals industry.

Flotation plants for which data have been handled in this manner included the following:

Commodity	Number and State
Barite	1 in Arkansas.
Do	2 in Georgia.
Bastnaesite	1 in California.
Ilmenite	1 in New York.
Kyanite	1 in Georgia.
Do	2 in Virginia.
Mercury	1 in Nevada.
Molybdenum	1 in Colorado.
Do	1 in New Mexico.
Talc	1 in Alabama.
Do	1 in Vermont.
Tungsten	1 in California.
Do	1 in North Carolina.
Vermiculite	1 in Montana.

Table 20.—Froth flotation plants in 1975, by State

State	Number	State	Number
Alabama	7	New Jersey	3
Arizona	21	New Mexico	15
Arkansas	1	New York	3
California	8	North Carolina	12
Colorado	14	Ohio	1
Connecticut	1	Oklahoma	1
Florida	19	Pennsylvania	16
Georgia	5	South Carolina	1
Idaho	9	Tennessee	9
Illinois	6	Texas	1
Indiana	1	Utah	9
Kentucky	5	Vermont	3
Louisiana	1	Virginia	16
Maine	1	Washington	2
Maryland	1	West Virginia	34
Michigan	7	Wisconsin	2
Missouri	8		
Montana	3	Total	252
Nevada	6		

Table 21.—Froth flotation in 1975

Plants			Ore treated (short tons)	Concentrates produced (short tons)	Energy used (kilowatt-hours)		Water used (gallons)		Rod consumption (pounds)		Ball consumption (pounds)		Liner consumption (pounds)	
Type	Number	Capacity (short tons per day)			Total (million)	Per ton	Total (million)	Per ton	Total	Per ton	Total	Per ton	Total	Per ton
Copper	18	323,000	92,190,000	2,164,546	1,490.8	16.2	78,276.1	850	11,517,479	0.309	116,524,715	1.264	9,579,182	0.104
Copper-molybdenum	15	514,000	145,430,300	2,640,789	2,559.7	17.6	111,230.4	765	41,503,669	.481	187,692,197	1.291	13,794,302	.095
Copper-lead-zinc	13	29,300	6,658,300	550,682	109.6	16.5	4,485.8	675	1,413,088	.228	2,666,989	.401	449,184	.205
Copper-zinc-iron	3	8,500	1,966,700	809,478	40.0	20.3	1,201.7	610	639,104	.341	1,669,931	.849	194,700	.099
Gold-silver	3	840	65,900	476	1.8	27.5	48.7	740	--	--	260,081	3.946	31,811	.483
Lead-zinc	21	30,900	7,510,000	952,592	163.8	21.8	6,294.8	840	1,311,806	.246	6,211,913	.827	819,090	.109
Zinc	10	19,600	3,139,800	212,373	58.1	18.5	1,943.4	620	813,267	.277	549,087	.214	390,436	.124
Barite	3	W	W	W	W	W	W	W	--	--	W	W	W	W
Bastnaesite	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Feldspar-mica-quartz	13	10,400	2,564,200	1,136,190	64.1	25.0	6,058.4	2,400	1,935,426	.929	--	--	305,221	.119
Fluorspar	3	1,420	274,500	85,784	18.8	68.3	465.4	1,700	--	--	212,106	.773	24,040	.088
Glass sand	22	40,000	7,348,900	6,068,400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ilmenite	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Iron ores	5	83,000	28,619,000	14,937,639	558.7	20.0	47,421.8	1,700	12,575,502	.886	65,752,034	2.137	8,783,200	.293
Kyanite	3	W	W	W	W	NA	NA	NA	NA	NA	NA	NA	NA	NA
Limestone-magnesite	5	1,950	402,300	340,900	8.3	20.7	216.1	540	NA	NA	NA	NA	NA	NA
Mercury	1	W	W	W	W	W	W	W	--	--	W	W	--	--
Molybdenum	2	W	W	W	W	W	W	W	--	--	W	W	W	W
Phosphate	19	56,200	75,076,300	17,996,370	668.6	8.9	236,944.5	3,150	NA	NA	NA	NA	NA	NA
Potash	8	49,000	13,861,000	3,350,462	229.8	16.6	4,009.1	290	NA	NA	NA	NA	NA	NA
Talc	2	W	W	W	W	W	W	W	NA	NA	W	W	NA	NA
Tungsten	2	W	W	W	W	W	W	W	W	W	W	W	W	W
Vermiculite	1	W	W	W	W	W	W	W	--	--	--	--	--	--
Anthracite and bituminous coal	78	64,300	13,079,000	8,178,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	252	1,611,800	422,525,000	60,267,319	6,540.6	15.8	527,382.0	1,270	72,597,824	.461	405,916,765	1.307	36,169,822	.117

NA Not available. W Withheld to avoid disclosing individual company confidential data; included in "Total."

Table 22.—Consumption of reagents by type and plants in froth flotation in 1975
(Pounds)

Type of plant	Modifiers		Activators		Depressants		Collectors		Frothers		Flocculants		Total	
	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton
Copper	579,762,467	6.289	1,561,158	0.309	454,263	0.025	5,240,543	0.057	4,168,712	0.045	4,468,060	0.087	[1]595,682,193	[1]6.461
Copper-molybdenum	472,176,915	3.247	--	--	22,004,117	.186	8,777,141	.060	9,639,811	.066	150,018	.003	[1]513,089,845	[1]3.528
Copper-lead-zinc	5,858,549	.911	964,327	.174	5,990,287	.920	750,453	.113	295,541	.132	27,068	.009	[1]13,982,121	[1]2.100
Copper-zinc-iron	26,417,008	13.432	1,143,897	.661	391,870	.199	770,212	.392	172,635	.088	6,660	.004	28,902,282	14.696
Gold-silver	3,154	.050	5,920	.098	3	.001	16,551	.251	1,990	.032	2,476	.041	30,094	.457
Lead-zinc	8,032,382	1.517	6,143,532	.818	3,633,921	.498	1,362,861	.181	1,120,375	.149	54,016	.016	[1]20,576,972	[1]2.740
Zinc	641,798	.926	1,514,471	.482	3,403	.015	276,836	.088	209,994	.067	223	.001	2,646,725	.843
Barite	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Bastnaesite	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Feldspar-mica-quartz	2,752,817	1.095	--	--	1,189,594	1.025	3,323,526	1.296	353,312	.190	797,508	.633	8,416,757	3.282
Fluorspar	3,943,660	14.366	214,870	.783	641,797	2.338	341,374	1.244	81,936	.298	102,230	.372	5,325,867	19.401
Glass sand	8,855,115	1.411	--	--	12,000	1.000	6,249,325	.850	869,306	.160	2,480	.011	[1]16,066,894	[1]2.186
Ilmenite	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Iron ores	36,544,400	2.679	--	--	14,168,700	1.730	20,199,234	.724	219,078	.031	1,982,100	.100	73,113,512	2.621
Kyanite	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Limestone-magnesite	663,263	4.077	--	--	815,372	5.012	490,674	1.220	96,835	.241	3,063	.014	2,069,207	5.143
Mercury	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Molybdenum	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Phosphate	92,480,557	1.248	--	--	--	--	324,846,212	4.327	--	--	56,090	.056	417,382,859	5.559
Potash	1,124,495	.087	--	--	3,021,748	.315	3,495,989	.252	3,293,469	.238	1,438,558	.104	12,374,259	.893
Talc	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Tungsten	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Vermiculite	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Anthracite and bituminous coal	297,669	.284	--	--	--	--	4,615,204	1.069	2,667,791	.207	1,302,971	.122	8,883,635	.679
Total	1,259,818,856	3.253	11,726,375	.497	58,853,073	.303	400,727,112	.970	26,617,972	.084	10,473,592	.069	[1]1,768,990,272	[1]4.186

W Withheld to avoid disclosing individual company confidential data; included in "Total."
[1] Includes other reagents as follows: Copper, 26,990 pounds (0.019 pound per ton); copper-molybdenum, 341,843 pounds (0.012 pound per ton); copper-lead-zinc, 95,896 pounds (0.089 pound per ton); lead-zinc, 229,885 pounds (0.061 pound per ton); glass sand, 78,668 pounds (0.089 pound per ton); and total, 773,282 pounds (0.021 pound per ton).

Table 23.—Consumption and value of reagents in froth flotation in 1970

Function and name	Consumption, pounds: Total	Consumption, pounds: Per ton
Modifier:		
Ammonia	29,218,398	1.264
Caustic soda	41,511,893	.518
Lime	999,955,837	3.662
Nalco	599,915	.012
Phosphate	8,001,772	.107
Salt	4,439,799	12.752
Soda ash	5,270,904	.474
Sodium silicate	28,590,021	.363
Sulfuric acid	275,378,709	3.678
Other	1,596,941	.032
Total: Pounds	1,394,564,189	3.933
Total: Value	$12,942,999	$0.037
Activator:		
Copper sulfate	7,772,946	.421
Sodium sulfide	336,974	.105
Other	861,993	.435
Total: Pounds	8,971,913	.382
Total: Value	$1,698,402	$0.072
Depressant:		
Aero Depressant 633	53,910	.105
Calcium cyanide	128,170	.011
Hydrofluoric acid	1,773,500	1.458
Phosphorus pentasulfide	66,001	.006
Quebracho	664,486	1.720
Sodium bichromate	163,567	.036
Sodium cyanide	3,205,212	.031
Sodium ferrocyanide	2,242,957	.087
Sodium fluoride	1,744,218	1.087
Sodium hydrosulfide	2,435,046	.141
Sodium sulfite	1,164,095	.471
Starch	6,071,186	.535
Sulfur dioxide	1,961,505	.433
Zinc hydrosulfite	50,295	.208
Zinc sulfate	3,585,302	.369
Other	5,401,128	.071
Total: Pounds	30,710,578	.173
Total: Value	$2,991,554	$0.017
Collector:		
Aerofloat 31	569,951	.051
Aerofloat 208	15,151	.117
Aerofloat 211	215,924	.069
Aerofloat 238	677,439	.017
Aerofloat 242	144,305	.071
Aerofloat 3302	431,668	.017
Aero Promoter 404	183,730	.038
Aero Promoter 801, 899, 3477, 3501	6,010,239	.461
Aero Promoter 825	212,124	.747
Amines	11,878,079	.391
Dow Z-200	2,667,922	.019
Fatty acids	91,439,446	2.048
Fuel oil	334,634,533	1.925
Kerosine	12,726,357	.723
Collector—Continued:		
Minerec	1,610,827	0.039
Petroleum sulfonate	471,000	.800
Potassium amyl xanthate	2,747,760	.310
Potassium ethyl xanthate	24,622	.091
Sodium Aerofloat	1,325,482	.027
Sodium ethyl xanthate	1,223,882	.027
Sodium isopropyl xanthate	3,438,814	.058
Sodium secondary-butyl xanthate	96,182	.052
Tall oil	123,348,799	3.865
Xanthates (unspecified)	1,108,400	.070
Other	3,189,421	.103
Total: Pounds	600,392,057	1.521
Total: Value	$22,626,490	$0.057
Frother:		
Aerofroths (unspecified)	1,373,847	.036
Aerofroth 65	1,253,219	.029
Barrett oil	647,516	.074
Cresylic acid	3,199,984	.046
Dowfroth 250	3,393,017	.061
Dowfroth 1012	73,009	.031
Methyl isobutyl carbinol	12,331,655	.082
Pine oil	3,759,602	.058
Other	172,619	.252
Total: Pounds	26,204,468	.082
Total: Value	$5,474,805	$0.017
Flocculant:		
Aerofloc 202	80,960	.066
Aerofloc 550	145,769	.066
Alum	431,195	.240
Calgon	48,564	.270
Guar	457,498	.078
Nalco	518,356	.010
Polyhall	95,812	.003
Separan	2,456,072	.040
Starch	858,690	1.742
Sulfuric acid	29,431	.166
Superfloc	273,760	.017
Other	402,531	.022
Total: Pounds	5,798,638	.032
Total: Value	$5,100,573	$0.028
Other (total):		
Pounds	136,100	.014
Value	$26,007	$0.003
Total reagents:		
Pounds	2,066,777,943	5.114
Value	$50,860,830	$0.126

Table 24.—Consumption and value of reagents in froth flotation in 1975

Function and name	Consumption, pounds	
	Total	Per ton
Modifier:		
Alum	343,307	0.432
Ammonia	30,133,682	.511
Caustic soda	20,135,833	.495
Hydrochloric acid	436,765	.063
Lignin sulfonate	393,401	.132
Lime	1,030,504,061	3.819
Nalco	787,949	.010
Phosphates	4,962,102	.052
Salt	3,365,022	12.259
Soda ash	4,371,392	1.761
Sodium silicate	21,433,039	.331
Sulfur dioxide	3,512,873	.493
Sulfuric acid	132,465,271	1.139
Other (Barochem, Calgon, Tergitol, miscellaneous)	6,974,159	.065
Total:		
Pounds	1,259,818,856	3.253
Value	$25,320,137	$0.065
Activator:		
Copper ammonium chloride, copper chloride	630,377	.202
Copper ammonium sulfate, copper sulfate	9,316,627	.616
Sodium hydrosulfide, sodium sulfide	1,779,371	.331
Total:		
Pounds	11,726,375	.497
Value	$2,551,045	$0.108
Depressant:		
Aero Drepressant 610, 633	71,859	.007
Caustic soda	195,927	.011
Guar	332,704	.070
Hydrofluoric acid	1,201,594	1.025
Phosphorus pentasulfide	883,832	.016
Quebracho	398,515	.936
Sodium cyanide	2,332,685	.025
Sodium dichromate	358,868	.061
Sodium ferrocyanide	2,183,795	.034
Sodium hydrosulfide	14,133,487	.572
Sodium silicate	2,807,982	4.756
Sodium sulfite	765,397	.479
Starch	16,657,178	.935
Zinc hydrosulfite	29,586	.182
Zinc sulfate	7,715,512	.682
Other (ammonium sulfide, lignin sulfonate, sodium siliofluoride, miscellaneous)	8,784,152	.099
Total:		
Pounds	58,853,073	.303
Value	$7,269,290	$0.037
Collector:		
Aerofloat 25, 31	124,407	.016
Aerofloat 208	7,534	.084
Aerofloat 211	231,296	.099
Aerofloat 238	795,108	.016
Aerofloat 242	58,415	.023
Aero Promoter 404, 407	407,262	.037
Aero Promoter 801, 825	143,409	.425
Aero Promoter 899	4,579,030	.919
Aero Promoter 3302	801,225	.014
Amines	9,407,166	.099
Dow Z-200	1,067,792	.026
Fatty acids	130,919,928	1.607
Fuel oil	205,148,644	1.011
Kerosine	6,945,824	.100
Collector—Continued		
Minerec	1,114,611	0.018
Petroleum sulfonate	764,079	.884
Potassium amyl xanthate	1,736,593	.022
Sodium Aerofloat	1,140,965	.028
Sodium butyl xanthate, sodium isobutyl xanthate	2,015,442	.091
Sodium ethyl xanthate	1,640,463	.046
Sodium isopropyl xanthate	1,676,650	.021
Tall oil	24,097,510	1.711
Xanthates (unspecified)	1,067,386	.057
Other	4,836,383	.157
Total:		
Pounds	400,727,122	.970
Value	$40,240,045	$0.097
Frother:		
Aerofroths (unspecified)	404,591	.235
Aerofroth 65	362,809	.020
Aerofroth 71	758,163	.033
Aerofroth 73, 77	46,363	.007
Barrett oil	2,370,699	.251
Cresylic acid	1,283,283	.030
Dowfroth 250	2,486,653	.038
Dowfroth 1012, 1263, 4082	202,176	.026
Methyl isobutyl carbinol	11,884,790	.061
Nalco	511,549	.407
Pine oil	1,587,062	.041
UCON 23	270,830	.034
UCON 48, 55, 122	727,370	.050
UCON 133, 190	713,415	.026
Other	3,008,219	.145
Total:		
Pounds	26,617,972	.084
Value	$7,705,165	$0.024
Flocculant:		
Aerofloc (unspecified)	208,892	.094
Aerofloc 30, 1202	17,288	.001
Aerofloc 550	18,471	.003
Alum	802,459	.806
Calgon	169,391	.019
Dowell	492,239	.138
Nalco	1,183,308	.036
Polyhall	1,064,634	.027
Separan	1,971,671	.077
Superfloc 16	132,208	.004
Superfloc 20	12,890	.010
Superfloc 127	19,398	.030
Superfloc 206	25,774	.001
Superfloc 330, unspecified	38,654	.032
Other (lime and miscellaneous)	4,316,315	.432
Total:		
Pounds	10,473,592	.069
Value	$4,292,252	$0.028
Other:		
Aerodri 100	539,051	.018
Carbon	149,439	.025
Miscellaneous	84,792	.071
Total:		
Pounds	773,282	.021
Value	$303,692	$0.008
Total reagents:		
Pounds	1,768,990,272	4.186
Value	$87,681,626	$0.208

Table 25.—Froth flotation of sulfide ores

Operating data	1960	1965	1970	1975
Plants:				
Number	95	108	105	86
Capacity short tons per day	546,000	622,000	862,000	990,000
Ore treated short tons	155,125,000	200,754,000	281,660,000	278,357,000
Concentrates produced do	5,855,000	7,213,000	8,863,000	7,395,000
Ratio of concentration	26.5:1	27.8:1	31.8:1	37.6:1

CONSUMPTION OF REAGENTS

Type	Total (pounds)				Pounds per ton			
	1960	1965	1970	1975	1960	1965	1970	1975
Modifier	489,706,448	765,676,534	1,198,742,990	1,107,425,094	3.710	4.114	4.408	4.051
Activator	7,858,889	8,983,093	8,487,774	11,333,305	.353	.281	.371	.492
Depressant	6,338,230	10,863,482	17,061,189	33,312,672	.089	.101	.104	.192
Collector	25,346,078	23,982,758	32,132,931	27,972,548	.163	.120	.114	.100
Frother	12,411,044	15,501,516	20,612,413	18,813,686	.080	.077	.073	.069
Flocculant	1,129,430	551,362	2,623,618	4,708,521	.026	.007	.018	.045
Other	--	112,349,217	136,100	694,614	--	4.867	.014	.019
Total	542,790,119	937,907,962	1,279,797,015	1,204,260,440	3.499	4.684	4.556	4.326

Table 26.—Froth flotation of metallic carbonate and oxide ores

Operating data	1960	1965	1970	1975
Plants:				
Number	13	14	13	13
Capacity short tons per day	14,000	48,000	65,000	90,000
Ore treated short tons	2,854,000	16,079,000	r 22,213,000	30,149,000
Concentrates produced do	941,000	7,086,000	13,040,000	15,582,000
Ratio of concentration	3.0:1	2.3:1	r 1.7:1	1.9:1

CONSUMPTION OF REAGENTS

Type	Total (pounds)				Pounds per ton			
	1960	1965	1970	1975	1960	1965	1970	1975
Modifier	6,639,418	15,279,991	31,635,105	39,456,840	2.368	3.444	4.713	2.642
Activator	1,280,205	--	--	--	5.000	--	--	--
Depressant	609,809	1,588,578	2,626,525	18,226,251	.320	1.466	1.276	1.923
Collector	22,572,698	23,694,707	31,818,552	22,931,300	8.049	1.479	1.074	.779
Frother	1,344,778	864,657	164,497	396,726	1.333	.090	.046	.046
Flocculant	1,306,029	458,285	220,271	1,985,163	1.618	.250	.016	.099
Total	33,752,937	41,886,218	66,464,950	82,996,280	12.036	2.614	2.244	2.821

r Revised.

Table 27.—Froth flotation of nonmetallic ores

Operating data	1960	1965	1970	1975
Plants:				
Number	55	64	56	75
Capacity ---------- short tons per day	144,000	191,000	378,000	467,500
Ore treated ---------- short tons	36,191,000	52,653,000	80,963,000	100,939,000
Concentrates produced ---------- do	11,888,000	17,376,000	23,823,000	29,111,000
Ratio of concentration	3.0:1	3.0:1	3.4:1	3.5:1

CONSUMPTION OF REAGENTS

Type	Total (pounds)				Pounds per ton			
	1960	1965	1970	1975	1960	1965	1970	1975
Modifier	82,455,910	54,889,380	r 161,469,886	112,639,253	3.566	1.278	r 2.155	1.151
Activator	2,987,585	511,677	484,139	393,070	.887	1.038	.820	.688
Depressant	9,231,057	4,346,025	r 11,022,864	7,314,150	.755	.451	r .959	.636
Collector	163,967,377	188,118,763	528,668,853	345,208,070	4.576	3.741	6.585	3.421
Frother	2,475,037	4,869,852	2,863,584	4,739,769	.166	.219	.119	.208
Flocculant	874,974	3,206,689	750,719	2,476,937	.129	.187	.062	.139
Other	--	--	--	78,668	--	--	--	.089
Total	261,991,940	255,942,386	705,260,045	472,849,917	7.311	5.089	8.749	4.685

r Revised.

Table 28.—Froth flotation of anthracite and bituminous coal

Operating data	1960	1965	1970	1975
Plants:				
Number	31	69	66	78
Capacity ---------- short tons per day	27,000	47,000	62,400	64,300
Raw coal treated ---------- short tons	4,112,000	9,500,000	13,006,000	13,079,000
Clean coal produced ---------- do	2,795,000	7,033,000	8,418,000	8,179,000

CONSUMPTION OF REAGENTS

Type	Total (pounds)				Pounds per ton			
	1960	1965	1970	1975	1960	1965	1970	1975
Modifier	1,609,352	298,274	2,716,208	297,669	3.841	1.922	2.861	0.284
Collector	8,142,058	4,055,306	7,771,721	4,615,204	3.015	1.988	2.039	1.069
Frother	584,798	1,554,801	2,563,974	2,667,791	.175	.166	.204	.207
Flocculant	393,885	2,301,001	2,204,030	1,302,971	.332	.365	.209	.122
Total	10,730,093	8,209,382	15,255,933	8,883,635	2.610	.864	1.173	.679

Table 29.—Froth flotation of copper ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	18	Total ---- millions	78,276.1
Capacity short tons per day	323,000	Per ton	850
Ore treated:		Rod consumption, pounds:	
Short tons	92,190,000	Total	11,517,479
Grade:		Per ton	0.309
Copper ---- percent	0.75	Ball consumption, pounds:	
Gold ---- ounce per ton	0.0020	Total	116,524,715
Silver ---- do	0.1066	Per ton	1.264
Energy used, kilowatt-hours:		Liner consumption, pounds:	
Total ---- millions	1,490.8	Total	9,579,182
Per ton	16.2	Per ton	0.104

CONCENTRATE PRODUCED

Type	Quantity (short tons)	Grade: Copper (percent)	Grade: Gold (ounce per ton)	Grade: Silver (ounces per ton)	Recovery (percent): Copper	Recovery (percent): Gold	Recovery (percent): Silver
Copper	2,164,546	25.50	0.0522	2.9473	80	61	67

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Lime	523,389,337	6.290
Nalco	633,553	.011
Phosphates	2,707,870	.128
Other (Calgon, sodium silicate, sulfuric acid)	53,031,707	2.169
Total:		
Pounds	579,762,467	6.289
Value	$9,626,136	$0.104
Activator:		
Pounds	1,561,158	.309
Value	$119,102	$0.024
Depressant: Aero Depressant 633, calcium cyanide, sodium cyanide, sodium sulfite, miscellaneous:		
Pounds	454,263	.025
Value	$102,878	$0.006
Collector:		
Aerofloat 25, Aerofloat 31, Aerofloat 238, Aerofloat 242	204,742	.015
Aero Promoter 404	135,644	.020
Dow Z-200	843,307	.033
Minerec	876,486	.023
Potassium amyl xanthate	212,180	.018
Sodium isopropyl xanthate	791,431	.015
Other (dithiophosphate, Sodium Aerofloat, sodium isobutyl xanthate, xanthate)	2,176,753	.115
Total:		
Pounds	5,240,543	.057
Value	$2,935,223	$0.032
Frother:		
Dowfroth 250, Dowfroth 1012	1,799,637	.057
Methyl isobutyl carbinol	624,025	.026
Pine oil	174,351	.024
UCON 55, UCON 122, UCON 133, UCON 190	917,020	.028
Other (Aerofroth 65, cresylic acid)	653,679	.038
Total:		
Pounds	4,168,712	.045
Value	$1,303,645	$0.014
Flocculant: Aerofloc 550, lime, Nalco, Polyhall, Separan, Superfloc 206:		
Pounds	4,468,060	.087
Value	$362,576	$0.007
Other:		
Pounds	26,990	.019
Value	$13,225	$0.009
Total reagents:		
Pounds	595,682,193	6.461
Value	$14,462,785	$0.157

Table 30.—Froth flotation of copper-molybdenum ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	15	Total ---- millions	111,230.4
Capacity short tons per day	514,000	Per ton	765
Ore treated:		Rod consumption, pounds:	
Short tons	145,430,300	Total	41,503,669
Grade:		Per ton	0.481
Copper ---- percent	0.53	Ball consumption, pounds:	
Gold ---- ounce per ton	0.0031	Total	187,692,197
Silver ---- do	0.0549	Per ton	1.291
Molybdenum -- percent	0.022	Liner consumption, pounds:	
Total ---- millions	2,559.7	Total	13,794,302
Energy used, kilowatt-hours:		Per ton	0.095
Per ton	17.6		

CONCENTRATES PRODUCED

Type	Quantity (short tons)	Grade: Copper (percent)	Grade: Gold (ounce per ton)	Grade: Silver (ounces per ton)	Grade: Molybdenum (percent)	Recovery (percent): Copper	Recovery (percent): Gold	Recovery (percent): Silver	Recovery (percent): Molybdenum
Copper	2,610,466	24.82	0.1012	2.3148	--	84	61	77	--
Molybdenite	30,323	--	--	--	56.76	--	--	--	53

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Lime	467,633,323	3.216
Phosphates	2,110,691	.029
Sulfuric acid	924,897	.039
Other (Nalco, sodium silicate, miscellaneous)	1,508,004	.019
Total:		
Pounds	472,176,915	3.247
Value	$7,999,062	$0.055
Depressant:		
Caustic soda	195,927	.011
Phosphorus pentasulfide	134,129	.004
Sodium cyanide	1,273,372	.018
Sodium ferrocyanide	2,332,414	.037
Other (Dextrin, sodium hydrosulfide, sodium hypochlorite, miscellaneous)	18,068,275	.246
Total:		
Pounds	22,004,117	.186
Value	$2,290,636	$0.019
Collector:		
Aerofloat 238	649,216	.017
Aero Promoter 404, Aero Promoter 3302	928,233	.015
Fuel oil	3,531,804	.037
Potassium amyl xanthate	1,333,376	.020
Sodium butyl xanthate, sodium ethyl xanthate, sodium isobutyl xanthate, sodium isopropyl xanthate	1,166,974	.015
Other (Dow Z-200, Minerec, Sodium Aerofloat, Stepanflote)	1,167,538	.019
Total:		
Pounds	8,777,141	.060
Value	$2,752,390	$0.019
Frother:		
Aerofroth 65, Aerofroth 73	134,740	.013
Dowfroth	581,549	.015
Methyl isobutyl carbinol	7,296,836	.062
UNCON 23, UNCON 48	752,174	.060
Other (pine oil, cresylic acid)	874,512	.025
Total:		
Pounds	9,639,811	.066
Value	$2,855,822	$0.020
Flocculant: Polyhall, Separan, Superfloc:		
Pounds	150,018	.003
Value	$175,900	$0.004
Other:		
Aerodri	193,815	.008
Miscellaneous	148,028	.026
Total:		
Pounds	341,843	.012
Value	$122,674	$0.004
Total reagents:		
Pounds	513,089,845	3.528
Value	$16,196,484	$0.111

Table 31.—Froth flotation of copper-lead-zinc ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	13	Total ---- millions	4,485.8
Capacity - short tons per day	29,300	Per ton	675
Ore treated:		Rod consumption, pounds:	
Short tons	6,658,300	Total	1,418,088
Grade:		Per ton	0.228
Copper ---- percent	0.29	Ball consumption, pounds:	
Lead ---- do	4.91	Total	2,666,989
Zinc ---- do	0.99	Per ton	0.401
Gold ---- ounce per ton	0.0286	Liner consumption, pounds:	
Silver ---- ounces per ton	2.0772	Total	449,184
Energy used, kilowatt-hours:		Per ton	0.205
Total ---- millions	109.6		
Per ton	16.5		

CONCENTRATES PRODUCED

Type	Quantity (short tons)	Grade: Copper (percent)	Lead (percent)	Zinc (percent)	Gold (ounce per ton)	Silver (ounces per ton)	Recovery (percent): Copper	Lead	Zinc	Gold	Silver
Copper	56,483	27.18	6.15	1.76	0.4100	191.3633	71	1	1	36	69
Lead	408,724	.68	71.23	1.31	.3163	5.8687	15	97	9	29	18
Zinc	85,475	.53	1.48	56.41	.0315	10.7790	2	--	79	5	6

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Caustic soda	75,328	0.017
Lime	2,467,483	1.286
Sulfur dioxide	3,006,071	.547
Other (soda ash, Dowfax, Cyquest)	309,667	.995
Total:		
Pounds	5,858,549	.911
Value	$282,483	$0.044
Activator:		
Copper chloride	630,377	.202
Copper sulfate	333,950	.139
Total:		
Pounds	964,327	.174
Value	$149,767	$0.027
Depressant:		
Sodium cyanide	72,743	.012
Sodium dichromate	358,868	.061
Sodium sulfite	608,817	.720
Starch	291,604	.076
Zinc sulfate	4,605,039	.832
Other	53,216	.086
Total:		
Pounds	5,990,287	.920
Value	$707,077	$0.109
Collector:		
Aerofloat 208, Aerofloat 241, Aerofloat 242, Aero Promoter 404	39,458	.047
Dow Z-200	123,311	.024
Potassium amyl xanthate	158,900	.100
Sodium isopropyl xanthate	379,760	.077
Other (Minerec, potassium ethyl xanthate)	49,024	.029
Total:		
Pounds	750,453	.113
Value	$365,346	$0.055
Frother:		
Aerofroth 71	198,874	.045
Dowfroth 250, Dowfroth 1012	48,249	.041
Methyl isobutyl carbinol	48,012	.022
Other	406	.001
Total:		
Pounds	295,541	.132
Value	$73,405	$0.033
Flocculant:		
Pounds	27,068	.009
Value	$17,733	$0.006
Other:		
Pounds	95,896	.089
Value	$47,469	$0.044
Total reagents:		
Pounds	13,982,121	2.100
Value	$1,643,280	$0.247

Table 32.—Froth flotation of copper-zinc-iron sulfide ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	3	Total ... millions	1,201.7
Capacity ... short tons per day	8,500	Per ton	610
Ore treated:		Rod consumption, pounds:	
Short tons	1,966,700	Total	639,104
Grade, percent:		Per ton	0.341
Copper	0.91	Ball consumption, pounds:	
Zinc	1.42	Total	1,669,931
Iron sulfide	31.90	Per ton	0.849
Energy used, kilowatt-hours:		Liner consumption, pounds:	
Total ... millions	40.0	Total	194,700
Per ton	20.3	Per ton	0.099

CONCENTRATES PRODUCED

Type	Quantity (short tons)	Grade: Gold (ounce per ton)	Grade: Silver (ounces per ton)	Grade: Copper (percent)	Grade: Zinc (percent)	Grade: Iron sulfide (percent)	Recovery (percent): Copper	Recovery (percent): Zinc	Recovery (percent): Iron
Copper	83,954	0.0006	1.1014	18.81	--	--	89	--	--
Zinc	28,024	--	--	--	51.51	--	--	59	--
Iron	697,500	--	--	--	--	56.69	--	--	76

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Lime	10,120,561	5.146
Other (Sodium silicate, sulfur dioxide, sulfuric acid)	16,296,447	8.705
Total:		
Pounds	26,417,008	13.432
Value	$586,552	$0.298
Activator: Copper sulfate:		
Pounds	1,143,897	.661
Value	$228,882	$0.132
Depressant: Guar, sodium cyanide, zinc sulfate:		
Pounds	391,870	.199
Value	$149,413	$0.076
Collector: Dow Z-200, Minerec, sodium isopropyl xanthate:		
Pounds	770,212	.392
Value	$150,139	$0.076
Frother: Cresylic acid, Dowfroth 250, methyl isobutyl carbinol:		
Pounds	172,635	.088
Value	$62,155	$0.032
Flocculant:		
Pounds	6,660	.004
Value	$11,219	$0.007
Total reagents:		
Pounds	28,902,282	14.696
Value	$1,188,360	$0.604

Table 33.—Froth flotation of gold-silver ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	3	Total ---- millions	48.7
Capacity -- short tons per day	840	Per ton	740
Ore treated:		Ball consumption, pounds:	
Short tons	65,900	Total	260,081
Grade, ounces per ton:		Per ton	3.946
Gold	0.4002	Liner consumption, pounds:	
Silver	2.3988	Total	31,811
Energy used, kilowatt-hours:		Per ton	0.483
Total ---- millions	1.8		
Per ton	27.5		

CONCENTRATE PRODUCED

Type	Quantity (short tons)	Grade (ounces per ton)		Recovery (percent)	
		Gold	Silver	Gold	Silver
Gold-silver	476	50.1828	281.6765	94	88

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier: Cyquest, soda ash:		
Pounds	3,154	0.050
Value	$2,698	$0.043
Activator:		
Pounds	5,920	.098
Value	$3,374	$0.056
Depressant: Sodium cyanide:		
Pounds	3	.001
Value	$1	--
Collector: Aerofloat 31, Aerofloat 208, Aero Promoter 404, potassium amyl xanthate, sodium isopropyl xanthate:		
Pounds	16,551	.251
Value	$12,728	$0.193
Frother: Aerofroth 71, Dowfroth 250, pine oil:		
Pounds	1,990	.032
Value	$1,191	$0.019
Flocculant:		
Pounds	2,476	.041
Value	$3,173	$0.053
Total reagents:		
Pounds	30,094	.457
Value	$23,165	$0.351

Table 34.—Froth flotation of lead-zinc ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	21	Total — millions	6,294.8
Capacity — short tons per day	30,900	Per ton	840
Ore treated:		Rod consumption, pounds:	
Short tons	7,510,000	Total	1,311,806
Grade:		Per ton	0.246
Lead — percent	4.78	Ball consumption, pounds:	
Zinc — do	4.06	Total	6,211,913
Copper — do	0.23	Per ton	0.827
Gold — ounce per ton	0.0499	Liner consumption, pounds:	
Silver — ounces per ton	2.3227	Total	819,090
Energy used, kilowatt-hours:		Per ton	0.109
Total — millions	163.8		
Per ton	21.8		

CONCENTRATES PRODUCED

Type	Quantity (short tons)	Grade: Copper (percent)	Grade: Lead (percent)	Grade: Zinc (percent)	Grade: Gold (ounce per ton)	Grade: Silver (ounces per ton)	Recovery (percent): Copper	Lead	Zinc	Gold	Silver
Lead	475,706	1.56	70.17	3.47	0.4762	13.8093	70	93	6	67	78
Zinc	476,886	.52	2.06	54.66	.1347	5.6775	10	2	86	15	11

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Lime	7,543,924	1.432
Soda ash	407,332	.662
Other (caustic soda, Nalco, phosphates, miscellaneous)	81,126	.047
Total:		
Pounds	8,032,382	1.517
Value	$277,596	$0.052
Activator: Copper sulfate, sodium sulfide:		
Pounds	6,143,532	.818
Value	$1,611,410	$0.215
Depressant:		
Sodium cyanide, sodium sulfite	534,598	.077
Zinc sulfate	3,099,323	.560
Total:		
Pounds	3,633,921	.498
Value	$572,959	$0.078
Collector:		
Aerofloat 31, Aerofloat 208, Aerofloat 211, Aerofloat 242	84,899	.159
Aero Promoter 404	51,877	.124
Potassium amyl xanthate	31,596	.080
Sodium ethyl xanthate	701,919	.178
Sodium isopropyl xanthate	357,746	.128
Other (Dow Z-200, potassium ethyl xanthate, Sodium Aerofloat, Thiocarbanilide)	134,824	.070
Total:		
Pounds	1,362,861	.181
Value	$660,709	$0.088
Frother:		
Aerofroth 65, Aerofroth 71	453,171	.338
Dowfroth 250, Dowfroth 1012	45,142	.032
Methyl isobutyl carbinol	603,458	.117
Other	18,604	.030
Total:		
Pounds	1,120,375	.149
Value	$444,243	$0.059
Flocculant:		
Superfloc 20, Superfloc 127	33,862	.017
Other (Nalco, Separan)	20,154	.012
Total:		
Pounds	54,016	.016
Value	$64,043	$0.019
Other:		
Aerodri 100	222,350	.070
Miscellaneous	7,535	.018
Total:		
Pounds	229,885	.061
Value	$109,476	$0.029
Total reagents:		
Pounds	20,576,972	2.740
Value	$3,740,436	$0.498

Table 35.—Froth flotation of zinc ores in 1975

OPERATING DATA

Plants:		Rod consumption, pounds:	
Number	10	Total	813,267
Capacity short tons per day	19,600	Per ton	0.277
Ore treated:		Ball consumption, pounds:	
Short tons	3,139,800	Total	549,087
Zinc percent	4.38	Per ton	0.214
Energy used, kilowatt-hours:		Liner consumption, pounds:	
Total millions	58.1	Total	390,436
Per ton	18.5	Per ton	0.124
Water used, gallons:			
Total millions	1,943.4		
Per ton	620		

CONCENTRATE PRODUCED

Quantity short tons	212,373
Zinc percent	60.21
Recovery do	93

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier: Lime:		
Pounds	641,798	0.926
Value	$17,416	$0.025
Activator:		
Copper sulfate	1,244,691	.506
Other	269,780	.396
Total:		
Pounds	1,514,471	.482
Value	$321,945	$0.103
Depressant:		
Pounds	3,403	.015
Value	$1,259	$0.006
Collector:		
Aerofloat 211	136,179	.078
Sodium Aerofloat	102,268	.055
Other (Aerofloat 242, Dow Z-200, sodium ethyl xanthate)	38,389	.048
Total:		
Pounds	276,836	.088
Value	$133,515	$0.043
Frother:		
Aerofroth 65	90,519	.058
Other (Aerofroth 77, Dowfroth 1012, methyl isobutyl carbinol, pine oil, UCON 23)	119,475	.071
Total:		
Pounds	209,994	.067
Value	$86,687	$0.028
Flocculant:		
Pounds	223	.001
Value	$223	$0.001
Total reagents:		
Pounds	2,646,725	.843
Value	$561,045	$0.179

Table 36.—Froth flotation of fluorspar ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	3	Total ---- millions	465.4
Capacity --- short tons per day	1,420	Per ton	1,700
Ore treated:		Ball consumption, pounds:	
Short tons	274,500	Total	212,106
Fluorspar ---- percent	38.06	Per ton	0.773
Energy used, kilowatt-hours:		Liner consumption, pounds:	
Total ---- millions	18.8	Total	24,040
Per ton	68.3	Per ton	0.088

CONCENTRATE PRODUCED

Fluorspar			Lead		Zinc	
Quantity (short tons)	Grade (percent)	Recovery (percent)	Quantity (short tons)	Grade (percent)	Quantity (short tons)	Grade (percent)
75,324	96.23	69	1,453	75.16	9,007	60.65

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Salt	3,365,022	12.258
Soda ash	459,507	1.674
Other (phosphates, caustic soda, sodium silicate)	119,131	.459
Total:		
Pounds	3,943,660	14.366
Value	$144,949	$0.528
Activator: Copper sulfate:		
Pounds	214,870	.783
Value	$89,835	$0.327
Depressant:		
Quebracho	384,904	1.402
Other (Aero Depressant 633, sodium cyanide, sodium silicate, starch, zinc hydrosulfite)	256,893	.936
Total:		
Pounds	641,797	2.338
Value	$200,410	$0.730
Collector:		
Aerofloat 211	46,128	.168
Other (potassium ethyl xanthate, fatty acids, Sodium Aerofloat, sodium ethyl xanthate, Stepanflote, miscellaneous)	295,246	1.076
Total:		
Pounds	341,374	1.244
Value	$96,921	$0.353
Frother:		
Methyl isobutyl carbinol	81,165	.296
Other	771	.007
Total:		
Pounds	81,936	.298
Value	$26,008	$0.095
Flocculant: Alum, Nalco, Superfloc:		
Pounds	102,230	.372
Value	$9,574	$0.035
Total reagents:		
Pounds	5,325,867	19.401
Value	$567,697	$2.068

Table 37.—Froth flotation of feldspar, mica, and quartz ores in 1975

OPERATING DATA

Plants:		Water used, gallons:	
Number	13	Total ---- millions	6,058.4
Capacity ---- short tons per day	10,400	Per ton	2,400
Ore treated ---- short tons	2,564,200	Rod consumption, pounds:	
Energy used, kilowatt-hours:		Total	1,935,426
Total ---- millions	64.1	Per ton	0.929
Per ton	25.0	Liner consumption, pounds:	
		Total	305,221
		Per ton	0.119

CONCENTRATES PRODUCED, SHORT TONS

Feldspar	530,536
Mica	93,133
Quartz	295,000
Other	217,521

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Caustic soda	733,900	0.377
Lime	610,016	.691
Sulfuric acid	1,201,451	1.134
Other (lignin sulfonate, sodium silicate)	207,450	1.356
Total:		
Pounds	2,752,817	1.095
Value	$107,046	$0.043
Depressant: Hydrofluoric acid:		
Pounds	1,189,594	1.025
Value	$360,313	$0.311
Collector:		
Amines	321,278	.319
Fatty acid	1,709,967	1.099
Other (fuel oil, miscellaneous)	1,292,281	1.186
Total:		
Pounds	3,323,526	1.296
Value	$794,742	$0.310
Frother:		
Pine oil	36,041	.052
Other (methyl isobutyl carbinol, Shellfroth, miscellaneous)	317,271	.273
Total:		
Pounds	353,312	.190
Value	$88,379	$0.048
Flocculant: Alum, Separan, sulfuric acid, Superfloc, miscellaneous:		
Pounds	797,508	.633
Value	$146,583	$0.116
Total reagents:		
Pounds	8,416,757	3.282
Value	$1,497,063	$0.584

Table 38.—Froth flotation of glass sand in 1975

OPERATING DATA

Plants:		
Number		22
Capacity	tons per day	40,000
Raw sand treated	short tons	7,348,900
Clean sand produced	do	6,068,400

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Caustic soda	1,302,104	0.731
Sulfuric acid	1,130,365	1.499
Other (alum, calcium chloride, lime, sodium silicate)	6,422,646	1.129
Total:		
Pounds	8,855,115	1.411
Value	$462,551	$0.074
Depressant:		
Pounds	12,000	1.000
Value	$4,620	$0.385
Collector:		
Aero Promoter 801, Aero Promoter 825, Aero Promoter 840	402,589	.598
Fatty acids	1,946,906	.843
Other (Aerofloat 31, amines, fuel oil, miscellaneous)	3,899,830	.684
Total:		
Pounds	6,249,325	.850
Value	$1,633,951	$0.222
Frother:		
Aerofroth	47,225	.076
Other (Dowfroth 250, miscellaneous)	822,081	.171
Total:		
Pounds	869,306	.160
Value	$365,139	$0.067
Flocculant: Polyhall, Steinhall, Superfloc:		
Pounds	2,480	.011
Value	$1,689	$0.008
Other:		
Pounds	78,668	.089
Value	$10,848	$0.012
Total reagents:		
Pounds	16,066,894	2.186
Value	$2,478,798	$0.337

Table 39.—Froth flotation of iron ores in 1975

OPERATING DATA

Plants:		Rod consumption, pounds:	
Number	5	Total	12,575,502
Capacity short tons per day	83,000	Per ton	0.886
Ore treated:		Ball consumption, pounds:	
Short tons	[1]28,619,000	Total	65,752,034
Iron percent	36.8	Per ton	2.137
Energy used, kilowatt-hours:		Liner consumption, pounds:	
Total millions	558.7	Total	8,783,200
Per ton	20.0	Per ton	0.293
Water used, gallons:			
Total millions	47,421.8		
Per ton	1,700		

CONCENTRATES PRODUCED

Type	Quantity (short tons)	Iron (percent) Grade	Iron (percent) Recovery
Iron	14,902,500	61.2	73
Other	35,139	--	--

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier: Caustic soda, lime, sodium silicate, sulfuric acid:		
Pounds	36,544,400	2.679
Value	$1,588,877	$0.116
Depressant:		
Pounds	14,168,700	1.730
Value	$1,416,870	$0.173
Collector: Aero Promoter 899, amines, fatty acids, fuel oil, xanthate, other:		
Pounds	20,199,234	.724
Value	$6,103,617	$0.219
Frother: Aerofroth 71, Aerofroth 77, methyl isobutyl carbinol:		
Pounds	219,078	.031
Value	$65,724	$0.009
Flocculant: Calgon, Separan, Superfloc 16:		
Pounds	1,982,100	.100
Value	$1,354,623	$0.068
Total reagents:		
Pounds	73,113,512	2.621
Value	$10,529,711	$0.378

[1] Includes magnetic concentrates upgraded by flotation.

Table 40.—Froth flotation of limestone-magnesite ores in 1975

OPERATING DATA

Plants:		Energy used, kilowatt-hours:	
Number	5	Total ---- millions	8.3
Capacity -- short tons per day	1,950	Per ton	20.7
Ore treated ---- short tons	402,300	Water used, gallons:	
Concentrate produced ---- do	340,900	Total ---- millions	216.1
		Per ton	540

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Pounds	663,263	4.077
Value	$37,282	$0.229
Depressant:		
Pounds	815,372	5.012
Value	$53,815	$0.331
Collector: Amines, fatty acids, fuel oil, other:		
Pounds	490,674	1.220
Value	$153,717	$0.382
Frother: Dowfax, pine oil, other:		
Pounds	96,835	.241
Value	$47,523	$0.118
Flocculant: Hercofloc, Separan:		
Pounds	3,063	.014
Value	$4,807	$0.019
Total reagents:		
Pounds	2,069,207	5.143
Value	$297,144	$0.739

Table 41.—Froth flotation of phosphate ores in 1975

OPERATING DATA

Plants		Ore treated		Energy used (kilowatt-hours)		Water used (gallons)	
Number	Capacity (short tons per day)	Quantity (short tons)	P_2O_5 (percent)	Total (millions)	Per ton	Total (millions)	Pe to
19	356,200	75,076,300	11.6	668.5	8.9	236,944.5	3,1

CONCENTRATE PRODUCED

Quantity	short tons	17,996,3
P_2O_5 content	percent	33
Recovery	do	68

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per to
Modifier:		
Ammonia	30,133,682	0.511
Caustic soda	7,477,797	.36
Sulfuric acid	54,869,078	.806
Total:		
Pounds	92,480,557	1.248
Value	$3,173,806	$0.043
Collector:		
Amines	5,323,426	.073
Fatty acids	136,407,784	1.817
Fuel oil	177,327,506	2.394
Kerosine	5,787,496	.085
Total:		
Pounds	324,846,212	4.327
Value	$21,513,348	$0.287
Flocculant:		
Pounds	56,090	.056
Value	$98,158	$0.098
Total reagents:		
Pounds	417,382,859	5.559
Value	$24,785,312	$0.330

Table 42.—Froth flotation of potash ores in 1975

OPERATING DATA

Plants		Ore-treated		Energy used (kilowatt-hours)		Water used (gallons)	
Number	Capacity (short tons per day)	Quantity (short tons)	K_2O (percent)	Total (millions)	Per ton	Total (millions)	Per ton
8	49,000	13,861,000	16.41	229.8	16.6	4,009.1	290

CONCENTRATE PRODUCED

Quantity	short tons	3,350,462
K_2O	percent	55.76
K_2O recovery	do	82

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Hydrochloric acid	436,765	0.045
Other (caustic soda, Marsperse, phosphates)	687,730	.053
Total:		
Pounds	1,124,495	.087
Value	$132,883	$0.010
Depressant: Guar, starch, other:		
Pounds	3,021,748	.315
Value	$561,601	$0.059
Collector:		
Amines	1,700,305	.123
Other (fuel oil, tall oil, other)	1,795,684	.247
Total:		
Pounds	3,495,989	.252
Value	$1,047,955	$0.076
Frother:		
Barrett oil	2,370,699	.251
Methyl isobutyl carbinol	908,498	.068
Other	14,272	.024
Total:		
Pounds	3,293,469	.238
Value	$365,944	$0.026
Flocculant:		
Nalco	438,487	.092
Polyhall	76,762	.008
Steinhall	802,881	.245
Other (Calgon and Superfloc)	120,428	.037
Total:		
Pounds	1,438,558	.104
Value	$610,223	$0.044
Total reagents:		
Pounds	12,374,259	.893
Value	$2,718,606	$0.196

Table 43.—Froth flotation of anthracite and bituminous coal in 1975

OPERATING DATA

Plants:	
Number	78
Capacity short tons per day	64,300
Raw coal treated short tons	13,079,000
Clean coal produced do	8,179,000

CONSUMPTION OF FLOTATION REAGENTS

Function and name	Total	Per ton
Modifier:		
Alum	142,080	0.280
Lime	14,242	.068
Other (ferrous sulfate, Nalco, sulfuric acid)	141,347	.320
Total:		
Pounds	297,669	.284
Value	$12,770	$0.012
Collector:		
Fuel oil	3,456,876	1.151
Kerosine	1,158,328	.883
Total:		
Pounds	4,615,204	1.069
Value	$239,478	$0.055
Frother:		
Aerofroths	393,261	.265
Methyl isobutyl carbinol	1,680,509	.170
Nalco	511,549	.407
Other	82,472	.289
Total:		
Pounds	2,667,791	.207
Value	$764,665	$0.059
Flocculant:		
Aerofloc	208,892	.904
Alum	283,474	.734
Calgon	40,843	.029
Dowell	492,239	.138
Nalco	169,791	.063
Other (Betz, Polyhall, Separan, Superfloc)	107,732	.149
Total:		
Pounds	1,302,971	.122
Value	$1,364,820	$0.128
Total reagents:		
Pounds	8,883,635	.679
Value	$2,381,733	$0.182

Statistical Summary

By Staff, Office of Technical Data Services

This chapter summarizes data on crude mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Included also are tables that show the principal mineral commodities exported from and imported into the United States, and that compare world and U.S. mineral production. The detailed data from which these tables were derived are contained in the individual commodity chapters of volume I and in the State chapters of volume II of this edition of the Minerals Yearbook.

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this chapter is what is normally termed "mine output." It usually refers to minerals or ores in the form in which they are first extracted from the ground, but customarily includes the product of auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. In the cases of gold, silver, copper, lead, zinc, and tin, the quantities are recorded on a mine basis (as the recoverable content of ore sold or treated). However, the values assigned to these quantities are based on the average selling price of refined metal, not on the mine value. Mercury is measured as recovered metal and valued at the average New York price for the metal.

The weight or volume units shown are those customarily used in the particular industries producing the commodities. Values shown are in current dollars, with no adjustment made to compensate for changes in the purchasing power of the dollar.

Table 1.—Value of crude mineral production[1] in the United States, by mineral group

(Million dollars)

Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total
1971	21,247	6,058	3,406	30,711
1972	22,061	6,482	3,642	32,185
1973	25,012	7,413	4,362	36,787
1974	40,937	r 8,642	5,552	r 55,131
1975	47,561	9,518	5,196	62,275

r Revised.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Mineral production [1] in the United States

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
MINERAL FUELS								
Asphalt and related bitumens, native: Bituminous limestone, sandstone, gilsonite ---short tons--	1,995,374	$10,303	2,088,657	$8,464	2,021,165	$16,666	1,901,715	$19,838
Carbon dioxide, natural ---thousand cubic feet--	1,228,741	165	1,134,986	259	966,118	237	1,070,024	279
Coal:								
Bituminous and lignite [2] ---thousand short tons--	595,386	4,561,983	591,738	5,049,612	603,406	9,502,347	648,438	12,472,486
Pennsylvania anthracite ---do---	7,106	85,251	6,830	90,260	6,617	144,695	6,203	198,481
Helium:								
Crude ---million cubic feet--	3,467	41,604	2,558	30,696	184	2,208	334	4,008
High-purity ---do---	629	15,673	647	16,121	699	18,105	745	19,915
Natural gas ---do---	22,531,698	4,180,462	22,647,549	4,894,072	21,600,522	6,573,402	20,108,661	8,945,062
Natural gas liquids:								
Natural gasoline and cycle products thousands 42-gallon barrels--	193,480	604,423	187,390	668,784	168,152	1,107,158	151,872	878,698
LPG ---do---	444,736	847,810	447,033	1,188,289	447,946	1,980,769	444,086	1,893,890
Peat ---thousand short tons--	607	7,112	621	7,547	706	10,989	746	12,294
Petroleum (crude) ---thousand 42-gallon barrels--	3,455,368	11,706,510	3,360,903	13,057,905	3,202,585	21,580,549	3,056,779	23,116,059
Total mineral fuels ---	XX	22,061,000	XX	25,012,000	XX	40,937,000	XX	47,561,000
NONMETALS (EXCEPT FUELS)								
Abrasive stones [3] ---short tons--	3,241	670	3,466	667	3,134	717	2,953	1,060
Asbestos ---do---	131,663	13,408	150,036	16,288	109,091	13,393	98,654	14,220
Barite ---thousand short tons--	906	14,883	1,104	16,688	1,106	16,822	1,287	20,673
Boron minerals ---do---	1,121	95,882	1,225	113,648	1,185	128,306	1,172	158,772
Bromine ---thousand pounds--	386,864	63,689	418,250	67,131	432,094	117,715	407,163	113,126
Calcium-magnesium chloride ---short tons--	W	W	609,300	17,581	r 739,100	r 24,552	594,400	29,047
Cement:								
Portland ---thousand short tons--	77,973	1,588,290	82,718	1,810,292	75,983	1,992,695	65,215	2,015,625
Masonry ---do---	3,777	100,269	4,057	119,547	3,371	111,106	2,868	111,801
Clays ---do---	59,456	303,022	64,351	354,058	60,796	422,542	49,047	424,556
Diatomite ---short tons--	576,089	37,554	608,906	36,083	664,303	50,693	573,000	45,812
Emery ---do---	2,883	W	2,884	W	W	W	3,487	W
Feldspar ---do---	746,212	10,623	791,900	12,830	853,702	14,482	684,898	11,893
Fluorspar ---do---	250,347	17,315	248,601	17,381	201,116	14,297	139,913	10,888
Garnet (abrasive) ---do---	18,916	1,957	22,772	2,381	24,684	2,550	17,204	1,690
Gem stones [e] ---	NA	2,728	NA	2,739	NA	4,583	NA	13,900
Gypsum ---thousand short tons--	12,328	48,504	13,558	56,650	11,999	52,894	9,751	44,654
Lime ---do---	20,290	339,304	21,090	365,849	21,606	473,685	19,133	523,805
Magnesium compounds from seawater and brine (except for metal) ---short tons, MgO equivalent--	729,472	63,915	853,907	77,733	907,492	96,742	W	W
Mica:								
Scrap ---thousand short tons--	160	4,353	177	6,082	137	5,475	135	5,219
Sheet ---pounds--	14,280	7	r 30,000	r 15	r 20,000	r 10	5,000	3
Perlite ---short tons--	544,594	6,231	543,683	5,591	555,000	7,024	512,000	7,282
Phosphate rock ---thousand short tons--	40,831	207,910	42,137	238,667	45,686	501,429	48,816	1,122,184

Potassium salts ----thousand short tons, K_2O equivalent--	2,659	106,680	2,603	112,613	2,552	r 159,148	2,501	223,098
Pumice ----thousand short tons--	3,813	6,539	3,937	8,881	3,937	9,121	3,892	11,203
Pyrites ----thousand long tons--	741	6,652	559	4,961	424	4,238	625	4,776
Salt ----thousand short tons--	45,022	296,772	43,910	306,103	46,536	360,763	41,030	368,063
Sand and gravel ----do----	914,324	1,200,701	983,629	1,359,370	r 904,646	r 1,421,237	789,436	1,416,346
Sodium carbonate (natural) ----do----	3,218	71,689	3,722	94,385	4,059	137,486	4,328	182,620
Sodium sulfate (natural) ----do----	701	11,396	672	11,597	684	16,411	667	27,667
Stone [4] ----do----	920,423	1,672,293	1,060,124	1,990,463	1,043,542	2,186,155	902,900	2,123,049
Sulfur, Frasch process ----thousand long tons--	7,613	132,385	7,438	138,578	7,898	241,066	6,077	304,843
Talc, soapstone, pyrophyllite ----short tons--	1,107,404	7,828	1,246,534	9,144	r 1,289,462	r 9,569	927,548	8,309
Tripoli ----do----	87,864	797	101,519	930	r 85,121	r 623	80,562	565
Vermiculite ----thousand short tons--	337	8,092	365	9,464	341	10,120	330	13,761
Value of items that cannot be disclosed: Aplite, natural and slag cement, graphite, iodine, kyanite, lithium minerals, magnesite, greensand marl, olivine, staurolite, wollastonite, and values of nonmetal items indicated by symbol W ----	XX	39,730	XX	28,926	XX	r 34,125	XX	157,180
Total nonmetals ----	XX	6,482,000	XX	7,413,000	XX	r 8.642,000	XX	9,518,000
METALS								
Antimony ore and concentrate short tons, antimony content--	489	386	545	688	661	2,040	886	2,131
Bauxite ----thousand long tons, dried equivalent--	1,812	23,238	1,879	26,635	1,949	25,663	1,772	25,083
Copper (recoverable content of ores, etc.) ----short tons--	1,664,840	1,704,796	1,717,940	2,044,346	1,597,002	2,468,964	1,413,366	1,814,763
Gold (recoverable content of ores, etc.) ----troy ounces--	1,449,943	84,967	1,175,750	115,000	1,126,886	180,009	1,052,252	169,928
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight--	77,884	950,365	90,654	1,163,710	84,985	1,388,447	75,695	1,620,599
Lead (recoverable content of ores, etc.) ----short tons--	618,915	186,046	603,024	196,465	663,870	298,742	621,464	267,230
Manganese ore (35% or more Mn) short tons, gross weight--	578	W	239	W	--	--	--	--
Manganiferous ore (5% to 35% Mn) ----do----	147,161	W	203,055	W	272,908	2,323	158,725	1,412
Mercury ----76-pound flasks--	7,333	1,601	2,171	621	2,189	617	7,366	1,165
Molybdenum (content of concentrate) -thousand pounds--	102,197	170,530	135,097	217,701	118,163	234,658	105,170	259,328
Nickel (content of ore and concentrate) ----short tons--	16,864	W	18,272	W	16,618	W	16,987	W
Rare-earth metal concentrates ----do----	19,520	8,479	31,273	13,780	35,218	15,966	W	W
Silver (recoverable content of ores, etc.) thousand troy ounces--	37,233	62,737	r 37,484	r 95,883	33,762	159,018	34,938	154,424
Tin ----long tons--	W	W	W	W	139	1,056	W	W
Titanium concentrate:								
Ilmenite ----short tons, gross weight--	739,801	16,739	804,355	r 20,128	r 755,338	22,715	702,252	26,946
Rutile ----do----	W	W	9,045	1,212	6,446	996	W	W
Tungsten ore and concentrate thousand pounds contained W--	7,045	18,104	7,059	19,154	7,836	37,413	5,490	29,090
Uranium (recoverable content U_3O_8) --thousand pounds--	25,758	162,272	25,803	167,718	23,227	243,884	22,877	281,388
Vanadium (recoverable in ore and concentrate) short tons--	4,887	30,867	4,377	26,611	4,870	38,266	4,743	49,329

See footnotes at end of table.

Table 2.—Mineral production[1] in the United States—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
METALS—Continued								
Zinc (recoverable content of ores, etc.) short tons	478,318	$169,803	478,850	$197,861	499,872	$358,908	469,335	$366,097
Value of items that cannot be disclosed: Beryllium, magnesium chloride for magnesium metal, manganiferous residuum, platinum-group metals (crude), zircon concentrate, and values of metal items indicated by symbol W	XX	50,650	XX	54,004	XX	72,772	XX	127,459
Total metals	XX	3,642,000	XX	4,362,000	XX	5,552,000	XX	5,196,000
Grand total	XX	32,185,000	XX	36,787,000	XX	r 55,131,000	XX	62,275,000

[e] Estimate. [r] Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2] Includes a small quantity of anthracite mined in States other than Pennsylvania.

[3] Grindstones, pulpstones, grinding pebbles, sharpening stones, and tube mill liners.

[4] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and soapstone, all included elsewhere in table.

Table 3.—Minerals produced in the United States and principal producing States in 1975

Mineral	Principal producing States, in order of quantity	Other producing States
Antimony ore and concentrate	Idaho and Mont.	
Aplite	Va.	
Asbestos	Calif., Vt., Ariz., N.C.	
Asphalt (native)	Tex., Utah, Ala., Mo.	
Barite	Nev., Mo., Ark., Ga	Alaska, Calif., Idaho, Ill., Mont., Tenn.
Bauxite	Ark., Ala., Ga.	
Beryllium concentrate	Utah	S. Dak.
Boron minerals	Calif.	
Bromine	Ark., Mich., Calif.	
Calcium-magnesium chloride	Mich. and Calif.	
Carbon dioxide (natural)	N. Mex., Colo., Calif., Utah.	
Cement	Tex., Calif., Pa., Mich	Ala., Ariz., Ark., Colo., Fla., Ga., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Minn., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N.C., Ohio, Okla., Oreg., S.C., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wis., Wyo.
Clays	Ga., Tex., Ohio, N.C	All other States except Alaska, R.I., Vt.
Coal	Ky., W. Va., Pa., Ill	Ala., Alaska, Ariz., Ark., Colo., Ga., Ind., Iowa, Kans., Md., Mo., Mont., N. Mex., N. Dak., Ohio, Okla., Tenn., Tex., Utah, Va., Wash., Wyo.
Copper (mine)	Ariz., Utah, N. Mex., Mont	Calif., Colo., Idaho, Maine, Mich., Mo., Nev., Okla., Oreg., Tenn., Wash., Wis.
Diatomite	Calif., Nev., Wash	Kans. and Oreg.
Emery	N.Y. and Oreg.	
Feldspar	N.C., Conn., Calif., Ga	Ariz., Colo., S. Dak., Wyo.
Fluorspar	Ill., Utah, Tex., Mont	Ky., Nev., N. Mex.
Garnet, abrasive	Idaho and N.Y.	
Gold (mine)	Nev., S. Dak., Utah, Ariz	Alaska, Calif., Colo., Idaho, Mont., N. Mex., Oreg., Tenn., Wash.
Graphite	Tex.	
Gypsum	Calif., Mich., Iowa, Tex	Ariz., Ark., Colo., Idaho, Ind., Kans., La., Mont., Nev., N. Mex., N.Y., Ohio, Okla., S. Dak., Utah, Va., Wash., Wyo.
Helium	Kans., Okla., Tex., Ariz	N. Mex.
Iodine	Mich.	
Iron ore	Minn., Mich., Calif., Mo	Ala., Ariz., Ark., Colo., Ga., Idaho, Mont., Nev., N. Mex., N.Y., Pa., S. Dak., Tex., Utah, Wis., Wyo.
Kyanite	Va. and Ga.	
Lead (mine)	Mo., Idaho, Colo., Utah	Ariz., Calif., Ill., Ky., Maine, Mont., Nev., N. Mex., N.Y., Oreg., Va., Wash., Wis.
Lime	Ohio, Pa., Tex., Mo	Ala., Ariz., Ark., Calif., Colo., Conn., Fla., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Md., Mass., Mich., Minn., Miss., Mont., Nebr., Nev., N. Mex., N.Y., N. Dak., Okla., Oreg., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wis., Wyo.
Lithium minerals	N.C., Nev., Calif.	
Magnesite	Nev.	
Magnesium chloride	Tex.	
Magnesium compounds	Mich., Calif., N.J., Fla	Del., Miss., Tex., Utah.
Manganiferous ore	Minn. and N. Mex.	
Manganiferous residuum	N.J.	
Marl, greensand	N.J.	
Mercury	Nev., Calif., N.Y.	
Mica, scrap	N.C., Ala., N. Mex., Ga	Ariz., Conn., Pa., S.C., S. Dak.
Molybdenum	Colo., Ariz., N. Mex., Utah	Calif. and Nev.
Natural gas	Tex., La., Okla., N. Mex	Ala., Alaska, Ariz., Ark., Calif., Colo., Fla., Ill., Ind., Kans., Ky., Md., Mich., Miss., Mo., Mont., Nebr., N.Y., N. Dak., Ohio, Pa., Tenn., Utah, Va., W. Va., Wyo.

Table 3.—Minerals produced in the United States and principal producing States in 1975—Continued

Mineral	Principal producing States, in order of quantity	Other producing States
Natural gas liquids	Tex., La., Okla., N. Mex	Ala., Alaska, Ark., Calif., Colo., Fla., Ill., Kans., Ky., Mich., Miss., Mont., Nebr., N. Dak., Pa., S. Dak., Utah, W. Va., Wyo.
Nickel	Oreg.	
Olivine	N.C. and Wash.	
Peat	Mich., Fla., Ill., Ind	Calif., Colo., Ga., Iowa, Maine, Md., Mass., Minn., Mont., N.J., N.Y., N. Dak., Ohio, Pa., S.C., Vt., Wash., Wis.
Perlite	N. Mex., Ariz., Calif., Colo	Idaho and Nev.
Petroleum, crude	Tex., La., Calif., Okla	Ala., Alaska, Ariz., Ark., Colo., Fla., Ill., Ind., Kans., Ky., Mich., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N. Dak., Ohio, Pa., S. Dak., Tenn., Utah, Va., W. Va., Wyo.
Phosphate rock	Fla., Idaho, Tenn., N.C	Ark., Mo., Mont., Utah, Wyo.
Platinum-group metals	Alaska.	
Potassium salts	N. Mex., Utah, Calif.	
Pumice	Oreg., Ariz., N. Mex., Nev	Calif., Colo., Hawaii, Idaho, Kans., Okla., Utah.
Pyrites ore and concentrate	Tenn., Colo., Ariz.	
Rare-earth metal concentrate	Calif. and Fla.	
Salt	La., Tex., N.Y., Ohio	Ala., Ariz., Calif., Colo., Kans., Mich., Nev., N. Mex., N. Dak., Okla., Utah, W. Va.
Sand and gravel	Calif., Alaska, Mich., Ill., Tex	All other States.
Silver (mine)	Idaho, Ariz., Colo., Utah	Alaska, Calif., Ill., Maine, Mich., Mo., Mont., Nev., N. Mex., N.Y., Okla., Oreg., S. Dak., Tenn., Va., Wash., Wis.
Sodium carbonate (natural)	Wyo. and Calif.	
Sodium sulfate (natural)	Calif., Tex., Utah.	
Staurolite	Fla.	
Stone	Ill., Pa., Tex., Mo	All other States except Del.
Sulfur (Frasch)	Tex. and La.	
Talc, soapstone, pyrophyllite	Vt., N.Y., Calif., Tex	Ala., Ark., Ga., Mont., Nev., N.C., Oreg., Va., Wash.
Tin	Colo., N. Mex., Alaska.	
Titanium concentrate	N.Y., Fla., N.J.	
Tripoli	Ill., Okla., Ark., Pa.	
Tungsten concentrate	Calif., Colo., Nev	Ariz., Idaho, Mont., Utah, Wash.
Uranium	N. Mex., Wyo., Colo., Utah	Tex. and Wash.
Vanadium	Ark., Colo., Idaho, Utah	N. Mex.
Vermiculite	Mont. and S.C.	
Wollastonite	N.Y.	
Zinc (mine)	Tenn., N.Y., Mo., Colo	Ariz., Calif., Idaho, Ill., Ky., Maine, Mont., Nev., N.J., N. Mex., Pa., Utah, Va., Wash., Wis.
Zircon concentrate	Fla.	

Table 4.—Value of mineral production in the United States and principal minerals produced in 1975

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$968,973	18	1.56	Coal, petroleum, cement, stone.
Alaska	480,745	24	.77	Petroleum, natural gas, stone, sand and gravel.
Arizona	1,288,423	14	2.07	Copper, molybdenum, cement, sand and gravel.
Arkansas	436,441	25	.70	Petroleum, bromine, natural gas, stone.
California	3,152,937	4	5.06	Petroleum, cement, natural gas, sand and gravel.
Colorado	960,800	20	1.54	Petroleum, molybdenum, coal, cement.
Connecticut	33,010	46	.05	Stone, sand and gravel, feldspar, lime.
Delaware	[1] 1,906	50	([2])	Sand and gravel, magnesium compounds, clays, gem stones.
Florida	1,775,500	9	2.85	Phosphate rock, petroleum, stone, cement.
Georgia	333,387	29	.54	Clays, stone, cement, sand and gravel.
Hawaii	49,710	44	.08	Stone, cement, sand and gravel, pumice.
Idaho	233,788	31	.38	Phosphate rock, silver, zinc, lead.
Illinois	1,490,598	11	2.39	Coal, petroleum, stone, sand and gravel.
Indiana	541,600	23	.87	Coal, cement, stone, petroleum.
Iowa	195,740	33	.31	Cement, stone, sand and gravel, coal.
Kansas	970,611	17	1.56	Petroleum, natural gas, natural gas liquids, cement.
Kentucky	2,738,859	6	4.40	Coal, petroleum, stone, natural gas.
Louisiana	8,513,275	2	13.67	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	36,741	45	.06	Cement, sand and gravel, zinc, stone.
Maryland	164,919	34	.26	Coal, stone, cement, sand and gravel.
Massachusetts	58,846	43	.09	Stone, sand and gravel, lime, clays.
Michigan	1,291,653	13	2.07	Iron ore, petroleum, cement, copper.
Minnesota	1,097,088	16	1.76	Iron ore, sand and gravel, stone, cement.
Mississippi	410,009	27	.66	Petroleum, natural gas, sand and gravel, cement.
Missouri	722,728	21	1.16	Lead, cement, stone, iron ore.
Montana	573,150	22	.92	Petroleum, copper, coal, cement.
Nebraska	111,905	40	.18	Petroleum, cement, sand and gravel, stone.
Nevada	258,390	30	.41	Copper, gold, sand and gravel, cement.
New Hampshire	17,107	48	.03	Sand and gravel, stone, clays, gem stones.
New Jersey	123,702	38	.20	Stone, sand and gravel, zinc, titanium concentrate.
New Mexico	2,091,541	8	3.36	Petroleum, natural gas, copper, potassium salts.
New York	397,728	28	.64	Cement, stone, zinc, salt.
North Carolina	152,880	36	.25	Stone, phosphate rock, lithium minerals, sand and gravel.
North Dakota	201,504	32	.32	Petroleum, coal, sand and gravel, natural gas liquids.
Ohio	1,356,454	12	2.18	Coal, petroleum, stone, lime.
Oklahoma	2,267,095	7	3.64	Petroleum, natural gas, natural gas liquids, coal.
Oregon	106,004	41	.17	Stone, sand and gravel, cement, nickel.
Pennsylvania	2,907,838	5	4.67	Coal, cement, stone, lime.
Rhode Island	6,198	49	.01	Sand and gravel, stone, gem stones.
South Carolina	115,467	39	.19	Cement, stone, sand and gravel, clays.
South Dakota	101,821	42	.16	Gold, cement, stone, sand and gravel.
Tennessee	424,768	26	.68	Coal, stone, zinc, cement.
Texas	15,529,931	1	24.94	Petroleum, natural gas, natural gas liquids, cement.
Utah	966,407	19	1.55	Petroleum, copper, coal, gold.
Vermont	28,779	47	.05	Stone, asbestos, sand and gravel, talc.
Virginia	1,261,974	15	2.03	Coal, stone, cement, sand and gravel.
Washington	158,505	35	.25	Cement, coal, sand and gravel, stone.
West Virginia	3,390,212	3	5.44	Coal, natural gas, petroleum, natural gas liquids.
Wisconsin	132,260	37	.21	Sand and gravel, stone, iron ore, cement.
Wyoming	1,644,438	10	2.64	Petroleum, sodium compounds, coal, natural gas.
Total	62,275,000	--	100.00	

[1] Incomplete total.
[2] Less than ½ unit.

Table 5.—Value of mineral production per capita and per square mile in 1975, by State

State	Area (square miles)	1975 population (thousands)	Value of mineral production: Total (thousands)	Per square mile: Dollars	Per square mile: Rank	Per capita: Dollars	Per capita: Rank
Alabama	51,609	3,615	$968,973	18,775	13	268	18
Alaska	586,412	365	480,745	820	50	1,317	5
Arizona	113,909	2,212	1,288,423	11,311	22	582	11
Arkansas	53,104	2,110	436,441	8,219	27	207	22
California	158,693	21,198	3,152,937	19,868	12	149	26
Colorado	104,247	2,541	960,800	9,217	25	378	14
Connecticut	5,009	3,100	33,010	6,590	31	11	47
Delaware	2,057	579	[1] 1,906	927	49	3	50
Florida	58,560	8,277	1,775,500	30,319	9	215	21
Georgia	58,876	4,931	333,387	5,663	32	68	34
Hawaii	6,450	868	49,710	7,707	29	57	36
Idaho	83,557	813	233,788	2,798	40	288	16
Illinois	56,400	11,197	1,490,598	26,429	10	133	28
Indiana	36,291	5,313	541,600	14,924	18	102	30
Iowa	56,290	2,861	195,740	3,477	36	68	33
Kansas	82,264	2,280	970,611	11,799	20	426	13
Kentucky	40,395	3,387	2,738,859	67,802	3	809	8
Louisiana	48,523	3,806	8,513,275	175,448	1	2,237	2
Maine	33,215	1,058	36,741	1,106	47	35	41
Maryland	10,577	4,122	164,919	15,592	17	40	40
Massachusetts	8,257	5,814	58,846	7,127	30	10	48
Michigan	58,216	9,111	1,291,653	22,187	11	142	27
Minnesota	84,068	3,921	1,097,088	13,050	19	280	17
Mississippi	47,716	2,341	410,009	8,593	26	175	23
Missouri	69,686	4,767	722,728	10,371	23	152	24
Montana	147,138	746	573,150	3,895	34	768	10
Nebraska	77,227	1,544	111,905	1,449	45	72	32
Nevada	110,540	590	258,390	2,338	42	438	12
New Hampshire	9,304	812	17,107	1,839	44	21	45
New Jersey	7,836	7,333	123,702	15,786	16	17	46
New Mexico	121,666	1,144	2,091,541	17,191	14	1,828	4
New York	49,576	18,076	397,728	8,023	28	22	44
North Carolina	52,586	5,441	152,880	2,907	38	28	43
North Dakota	70,665	637	201,504	2,852	39	316	15
Ohio	41,222	10,735	1,356,454	32,906	6	126	29
Oklahoma	69,919	2,715	2,267,095	32,425	7	835	7
Oregon	96,981	2,284	106,004	1,093	48	46	37
Pennsylvania	45,333	11,860	2,907,838	64,144	4	245	20
Rhode Island	1,214	931	6,198	5,105	33	7	49
South Carolina	31,055	2,816	115,467	3,718	35	41	39
South Dakota	77,047	681	101,821	1,322	46	150	25
Tennessee	42,244	4,173	424,768	10,053	24	102	31
Texas	267,338	12,238	15,529,931	58,092	5	1,269	6
Utah	84,916	1,203	966,407	11,381	21	803	9
Vermont	9,609	472	28,779	2,995	37	61	35
Virginia	40,817	4,981	1,261,974	30,918	8	253	19
Washington	68,192	3,559	158,505	2,324	43	45	38
West Virginia	24,181	1,799	3,390,212	140,201	2	1,884	3
Wisconsin	56,154	4,589	132,260	2,355	41	29	42
Wyoming	97,914	376	1,644,438	16,795	15	4,374	1
Total	3,615,055	212,322	62,275,000	17,227	--	293	--

[1] Incomplete total.

Table 6.—Mineral production [1] in the United States, by State

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
ALABAMA								
Cement:								
Masonry ---- thousand short tons	[2] 407	[2] $11,221	[2] 425	[2] $13,074	314	$11,322	262	$10,253
Portland ---- do	2,360	48,577	2,396	55,820	2,190	61,990	1,968	62,599
Clays [3] ---- do	2,850	7,512	2,934	8,788	2,995	13,298	2,231	9,077
Coal (bituminous) ---- do	20,814	200,430	19,230	211,695	19,824	432,036	22,644	600,767
Iron ore (usable) ---- thousand long tons, gross weight	327	1,912	271	1,408	W	W	W	W
Lime ---- thousand short tons	739	11,751	881	14,050	1,054	22,346	985	29,404
Natural gas ---- million cubic feet	3,644	1,282	11,271	4,307	27,865	20,704	37,814	32,898
Petroleum (crude) ---- thousand 42-gallon barrels	9,934	30,466	11,677	41,772	13,323	113,808	13,477	136,541
Sand and gravel ---- thousand short tons	6,352	8,530	9,805	13,870	12,454	19,120	9,232	17,376
Stone ---- do	[4] 18,485	[4] 42,027	[4] 20,043	[4] 40,117	[4] 23,773	[4] 60,231	22,252	61,515
Value of items that cannot be disclosed: Asphalt (native), bauxite, cement (slag, 1972–73), clay (bentonite), mica (scrap), natural gas liquids, salt, stone (dimension, 1972–74), talc, and values indicated by symbol W	XX	7,533	XX	8,155	XX	9,891	XX	8,543
Total	XX	371,241	XX	413,056	XX	764,746	XX	968,973
ALASKA								
Barite ---- thousand short tons	W	W	W	W	20	401	2	30
Coal (bituminous) ---- do	668	W	694	W	700	W	766	W
Gem stones	NA	57	NA	57	NA	57	NA	57
Gold (recoverable content of ores, etc.) ---- troy ounces	8,639	506	7,107	695	9,146	1,461	14,980	2,419
Lead (recoverable content of ores, etc.) ---- short tons	--	--	6	2	--	--	--	--
Natural gas ---- million cubic feet	125,596	18,463	131,007	19,483	128,935	21,919	160,270	48,402
Petroleum (crude) ---- thousand 42-gallon barrels	72,893	235,444	72,323	261,877	70,603	347,408	69,834	364,630
Sand and gravel ---- thousand short tons	14,187	15,214	14,999	19,913	r 43,644	r 22,954	48,145	25,780
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	(5)	(5)	1	2	1	3	W	W
Stone ---- thousand short tons	652	3,012	5,967	12,741	5,484	12,947	8,877	26,649
Tin ---- long tons	W	W	5	12	W	W	11	60
Value of items that cannot be disclosed: Copper (1974), mercury (1972–74), natural gas liquids, platinum-group metals, uranium (1972–73), and values indicated by symbol W	XX	13,442	XX	14,156	XX	11,453	XX	12,718
Total	XX	286,138	XX	328,938	XX	r 418,603	XX	480,745
ARIZONA								
Clays ---- thousand short tons	[3] 134	[3] 355	[3] 117	[3] 459	199	622	129	483
Coal (bituminous) ---- do	W	W	3,247	W	6,448	W	6,986	W
Copper ---- short tons	908,612	930,419	927,271	1,103,453	858,783	1,327,678	813,211	1,044,162
Gem stones	NA	168	NA	170	NA	1,500	NA	5,000
Gold (recoverable content of ores, etc.) ---- troy ounces	102,996	6,036	102,848	10,060	90,586	14,470	85,790	13,854
Gypsum ---- thousand short tons	W	W	158	669	141	473	117	419
Helium (high-purity) ---- million cubic feet	W	W	W	W	W	W	W	W

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
ARIZONA—Continued								
Iron ore (usable) ____thousand long tons, gross weight__	W	W	W	W	W	W	W	W
Lead (recoverable content of ores, etc.) ____short tons__	1,763	$530	763	$248	1,059	$476	420	$181
Lime ____thousand short tons__	356	6,024	365	7,019	422	9,071	512	12,444
Mica (scrap) ____do____	W	W	W	W	2	82	2	65
Molybdenum (content of concentrate) ____thousand pounds__	27,216	46,791	37,657	59,372	28,346	57,067	25,030	61,411
Natural gas ____million cubic feet__	442	80	125	23	224	45	208	58
Petroleum (crude) ____thousand 42-gallon barrels__	993	3,226	804	3,103	740	3,885	635	3,332
Pumice ____thousand short tons__	915	722	853	715	846	865	856	1,294
Sand and gravel ____do____	24,842	32,420	27,440	38,503	23,417	41,906	17,222	36,490
Silver (recoverable content of ores, etc.) ____thousand troy ounces__	6,653	11,210	7,199	18,416	6,356	29,935	6,286	27,783
Stone ____thousand short tons__	4,638	8,018	4,265	9,469	4,932	11,479	3,404	11,030
Zinc (recoverable content of ores, etc.) ____short tons__	10,111	3,589	8,427	3,482	9,699	6,964	8,655	6,751
Value of items that cannot be disclosed: Asbestos, cement, clay (fire, 1972–73), diatomite (1972), feldspar, fluorspar (1972–73), perlite, pyrites, salt (1975), tungsten, and values indicated by symbol W ____	XX	41,416	XX	49,827	XX	55,716	XX	63,666
Total ____	XX	1,091,004	XX	1,304,988	XX	1,562,234	XX	1,288,423
ARKANSAS								
Bauxite ____thousand long tons, dried equivalent__	1,634	21,010	1,686	23,884	1,731	23,597	1,543	22,956
Clays ____thousand short tons__	[3] 885	[3] 990	[3] 1,446	[3] 1,412	984	1,597	995	2,232
Coal (bituminous) ____do____	428	4,676	434	5,806	455	9,673	488	16,000
Gem stones ____	NA	32	NA	50	NA	60	NA	70
Iron ore ____thousand long tons, gross weight__	W	W	W	W	4	W	(5)	14
Lime ____thousand short tons__	150	2,456	177	2,742	187	3,189	170	3,848
Natural gas ____million cubic feet__	166,522	28,808	157,529	28,985	123,975	32,234	116,237	40,334
Natural gas liquids:								
Natural gasoline and cycle products __thousand 42-gallon barrels__	261	854	204	861	199	1,344	196	1,360
LP gases ____do____	546	1,420	449	1,688	418	2,491	407	2,377
Petroleum (crude) ____do____	18,519	58,335	18,016	70,618	16,527	122,817	16,133	143,336
Sand and gravel ____thousand short tons__	11,574	16,558	12,465	20,625	14,878	29,922	12,415	25,794
Stone ____do____	16,317	25,020	16,223	26,209	20,381	38,905	17,419	38,796
Value of items that cannot be disclosed: Abrasive stones, barite, bromine, cement, clay (kaolin, 1972–73), gypsum, phosphate rock (1975), soapstone, tripoli, vanadium, and values indicated by symbol W ____	XX	81,020	XX	90,825	XX	r 140.589	XX	139,324
Total ____	XX	241,179	XX	273,705	XX	r 406,418	XX	436,441
CALIFORNIA								
Asbestos ____short tons__	90,967	8,673	105,663	10,886	58,331	5,697	W	W
Barite ____thousand short tons__	4	34	11	152	4	W	1	W
Boron minerals ____do____	1,121	95,882	1,225	113,648	1,185	128,306	1,172	158,772

Cement ---do---	9,086	182,308	9,395	201,892	8,264	210,520	7,327	232,584
Clays ---do---	2,706	7,387	2,723	6,853	2,497	7,626	[3] 2,387	[3] 7,373
Copper (recoverable content of ores, etc.) ---short tons---	598	612	369	440	194	300	344	441
Diatomite ---thousand short tons---	W	W	W	W	W	W	354	31,186
Gem stones ---	NA	215	NA	220	NA	220	NA	220
Gold (recoverable content of ores, etc.) ---troy ounces---	3,974	233	3,647	357	5,049	807	9,606	1,551
Gypsum ---thousand short tons---	1,525	4,965	1,778	5,834	1,716	6,642	1,446	6,332
Lead (recoverable content of ores, etc.) ---short tons---	1,153	347	44	r 14	35	16	66	28
Lime ---thousand short tons---	608	13,059	632	13,602	600	14,877	595	18,626
Magnesium compounds from seawater and bitterns (partly estimated) ---short tons, MgO equivalent---	175,654	18,421	184,105	19,233	163,847	18,356	W	W
Mercury ---76-pound flasks---	5,835	1,274	1,219	349	1,311	370	W	W
Natural gas ---million cubic feet---	487,278	179,318	449,369	167,615	365,354	160,756	318,308	222,816
Natural gas liquids:								
Natural gasoline and cycle products---thousand 42-gallon barrels---	8,468	27,664	6,865	23,475	5,709	26,104	4,847	29,543
LP gases ---do---	5,847	15,962	5,329	19,824	5,095	29,296	4,481	20,568
Peat ---thousand short tons---	29	620	21	373	14	322	W	W
Petroleum (crude) ---thousand 42-gallon barrels---	347,022	940,430	336,075	1,045,193	323,003	1,710,350	322,199	1,943,048
Pumice ---thousand short tons---	731	1,507	768	3,237	909	3,219	348	2,762
Rare-earth metal concentrates ---short tons---	W	W	W	W	34,284	15,798	W	W
Salt ---thousand short tons---	1,621	14,860	1,507	15,533	W	W	W	W
Sand and gravel ---do---	117,288	162,619	117,470	176,286	105,191	176,213	88,445	168,248
Silver (recoverable content of ores, etc.) ---thousand troy ounces---	175	296	56	143	42	197	80	353
Stone ---thousand short tons---	37,218	65,811	43,838	77,175	45,709	91,891	33,152	72,740
Talc, soapstone, pyrophyllite ---short tons---	155,155	1,186	179,191	1,501	r 163,841	r 1,676	152,978	1,598
Zinc (recoverable content of ores, etc.) ---do---	1,202	427	20	8	8	6	206	161
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, carbon dioxide, cement (masonry 1972–73), clays (ball and kaolin, 1975), coal (lignite, 1972), feldspar, iron ore, lithium minerals, molybdenum, perlite, potassium salts, sodium carbonate and sulfate, tungsten concentrate, and values indicated by symbol W ---	XX	107,266	XX	137,843	XX	r 187,684	XX	233,987
Total ---	XX	1,851,376	XX	2,041,686	XX	r 2,797,249	XX	3,152,937

COLORADO

Carbon dioxide ---thousand cubic feet---	W	W	W	W	123,106	W	229,382	W
Clays ---thousand short tons---	747	1,533	794	1,710	663	1,588	480	1,101
Coal (bituminous) ---do---	5,522	35,637	6,233	46,190	6,896	64,677	8,219	135,872
Copper (recoverable content of ores, etc.) ---short tons---	3,944	4,039	3,123	3,716	3,012	4,657	3,560	4,571
Gem stones ---	NA	131	NA	131	NA	135	NA	145
Gold (recoverable content of ores, etc.) ---(troy ounces)---	61,100	3,580	63,422	6,203	52,083	8,320	55,483	8,960
Gypsum ---thousand short tons	W	W	151	568	191	800	185	782
Lead (recoverable content of ores, etc.) ---short tons---	31,346	9,423	28,112	9,159	24,609	11,074	27,088	11,648
Lime ---thousand short tons---	187	4,070	178	3,371	198	3,815	198	4,577
Mica, sheet ---pounds---	14,280	7	--	--	--	--	--	--
Natural gas ---million cubic feet---	116,949	19,297	137,725	24,304	144,629	28,926	171,629	44,624
Natural gas liquids:								
Natural gasoline and cycle products---thousand 42-gallon barrels---	1,245	3,349	1,424	4,295	1,574	9,319	1,742	9,378
LP gases ---do---	1,749	3,673	1,978	6,488	2,580	14,190	4,821	22,803
Peat ---thousand short tons---	39	210	28	163	30	201	37	280

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
COLORADO—Continued								
Perlite ----thousand short tons--	W	W	W	W	W	W	5	$73
Petroleum (crude) ----thousand 42-gallon barrels--	32,015	$109,171	36,590	$155,507	37,508	$283,904	38,809	365,654
Pumice ----thousand short tons--	59	W	W	W	W	W	W	W
Sand and gravel ----do----	28,318	34,631	33,767	45,493	23,793	39,674	20,019	34,850
Silver (recoverable content of ores, etc.) ----thousand troy ounces--	3,664	6,174	3,598	9,204	2,784	13,113	3,366	14,878
Stone ----thousand short tons--	4,507	9,599	6,357	14,003	6,572	15,109	5,315	10,940
Uranium (recoverable content U_3O_8) ----thousand pounds--	1,877	11,825	1,888	12,274	W	W	W	W
Zinc (recoverable content of ores, etc) ----short tons--	63,801	22,649	58,339	24,106	49,489	35,533	48,460	37,799
Value of items that cannot be disclosed: Beryllium concentrate (1972), cement, feldspar, fluorspar (1972–74), iron ore, molybdenum, pyrites, salt, tin, tungsten, vanadium, and values indicated by symbol W ----	XX	146,843	XX	164,806	XX	215,264	XX	251,865
Total ----	XX	425,841	XX	531,691	XX	750,299	XX	960,800
CONNECTICUT								
Clays ----thousand short tons--	157	292	162	320	156	363	116	307
Feldspar ----short tons--	W	W	77,206	W	W	W	W	W
Gem stones ----	NA	16	NA	16	NA	15	NA	W
Lime ----thousand short tons--	W	W	W	W	33	1,148	23	1,013
Mica (scrap) ----do----	2	W	3	W	2	W	W	W
Sand and gravel ----do----	6,763	11,270	7,806	12,788	6,345	11,272	4,900	10,040
Stone ----do----	8,719	19,695	9,682	21,305	8,457	21,134	7,332	20,117
Value of items that cannot be disclosed: Mica (sheet, 1974) and values indicated by symbol W ----	XX	1,850	XX	2,375	XX	r 1,433	XX	1,533
Total ----	XX	33,123	XX	36,804	XX	r 35,365	XX	33,010
DELAWARE								
Clays ----thousand short tons--	15	9	15	9	14	8	9	6
Gem stones ----	NA	W	NA	W	NA	2	NA	W
Sand and gravel ----thousand short tons--	2,257	2,660	3,408	3,678	2,396	3,783	976	1,900
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W ----	XX	202	XX	202	XX	W	XX	W
Total ----	XX	2,871	XX	3,889	XX	[6] 3,793	XX	[6] 1,906
FLORIDA								
Cement:								
Masonry ----thousand short tons--	213	6,901	256	8,706	235	4,737	W	W
Portland ----do----	2,425	59,773	2,725	72,666	2,562	75,133	1,721	62,525
Clays ----do----	[3] 922	[3] 10,336	1,139	13,718	[3] 808	[3] 14,261	712	17,063
Lime ----do----	180	3,527	187	4,026	185	5,315	199	7,708
Natural gas ----million cubic feet--	15,521	4,967	33,857	11,613	38,137	20,441	44,383	43,185

Peat ----thousand short tons--	45	362	44	384	67	616	82	1,037
Petroleum (crude) ----thousand 42-gallon barrels--	16,897	W	32,695	150,070	36,351	351,331	41,877	490,258
Sand and gravel ----thousand short tons--	22,363	17,009	20,167	21,415	24,372	33,400	13,237	20,199
Stone [4] ----do----	53,093	81,621	61,735	103,595	54,560	100,378	39,071	73,372
Titanium concentrate (rutile) ----short tons--	W	W	9,045	1,212	6,446	996	W	W
Value of items that cannot be disclosed: Clay (kaolin, 1972, 1974), kyanite (1972–73), magnesium compounds, natural gas liquids, phosphate rock, rare-earth metal concentrate, staurolite, stone (selected), titanium concentrate (ilmenite), zircon concentrate, and values indicated by symbol W ----	XX	242,136	XX	213,695	XX	437,287	XX	1,060,153
Total ----	XX	426,632	XX	601,100	XX	1,043,895	XX	1,775,500
GEORGIA								
Cement:								
Masonry ----thousand short tons--	68	1,569	67	2,126	40	1,304	W	W
Portland ----do----	1,260	27,286	1,201	28,124	1,150	31,535	828	25,822
Clays ----do----	[3] 6,227	[3] 132,322	[3] 7,721	[3] 160,419	[3] 7,692	[3] 203,936	6,156	195,300
Feldspar ----short tons----	W	W	51,523	W	W	W	W	W
Peat ----thousand short tons--	W	W	([5])	4	1	6	([5])	5
Sand and gravel ----do----	3,816	4,729	4,976	6,781	4,989	9,639	5,105	8,818
Stone ----do----	37,074	82,484	40,841	97,506	40,321	105,582	30,084	91,157
Talc ----short tons--	45,842	338	38,000	114	33,850	102	27,400	82
Value of items that cannot be disclosed: Barite, bauxite, clay (fire 1972–74), coal (1975), iron ore, kyanite, mica (scrap), rare-earth metal concentrate (1972–74), titanium concentrate, zircon concentrate, and values indicated by symbol W ----	XX	9,589	XX	10,405	XX	10,996	XX	12,203
Total ----	XX	258,317	XX	305,479	XX	363,100	XX	333,387
HAWAII								
Cement:								
Masonry ----thousand short tons--	13	384	16	537	14	706	13	762
Portland ----do----	402	10,732	453	13,213	487	16,405	456	19,942
Gem stones ----	NA	57	NA	W	NA	W	NA	W
Lime ----thousand short tons--	7	266	6	238	6	221	6	250
Pumice, pumicite, volcanic ash ----do----	379	762	354	611	385	792	318	912
Sand and gravel ----do----	609	1,893	753	2,012	990	2,379	671	2,460
Stone ----do----	[4] 5,005	[4] 13,494	7,180	18,466	[4] 7,638	[4] 21,370	7,569	25,319
Value of items that cannot be disclosed: Clays, salt (1972–73), stone (dimension, 1972, 1974), and values indicated by symbol W ----	XX	486	XX	70	XX	169	XX	65
Total ----	XX	28,074	XX	35,147	XX	42,042	XX	49,710
IDAHO								
Antimony ore and concentrate----short tons, antimony content--	345	303	322	406	445	W	W	W
Clays ----thousand short tons--	57	415	42	227	[3] 9	[3] 10	30	284
Copper (recoverable content of ores, etc.) ----short tons--	2,942	3,013	3,625	4,314	2,841	4,393	3,192	4,099
Gem stones ----	NA	105	NA	110	NA	120	NA	120
Gold (recoverable content of ores, etc.) ----troy ounces--	2,884	169	2,696	264	2,898	463	2,529	408
Gypsum ----thousand short tons--	--	--	W	W	W	W	W	W

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
IDAHO—Continued								
Lead (recoverable content of ores, etc.) ..... short tons	61,407	$18,459	61,744	$20,116	51,717	$23,273	50,395	$21,670
Mercury ..... 76-pound flasks	161	35	--	--	--	--	--	--
Pumice ..... thousand short tons	W	W	80	110	108	182	111	187
Sand and gravel ..... do	7,696	10,294	8,393	10,246	7,665	10,484	6,881	12,768
Silver (recoverable content of ores, etc.) ..... thousand troy ounces	14,251	24,012	13,620	34,840	12,436	58,572	13,868	61,297
Stone ..... thousand short tons	3,094	7,042	2,972	8,096	3,528	9,868	3,316	8,952
Zinc (recoverable content of ores, etc.) ..... short tons	38,647	13,720	46,107	19,052	39,469	28,339	40,926	31,922
Value of items that cannot be disclosed: Barite (1974–75), cement, clay (fire, 1974), abrasive garnet, iron ore, lime, perlite, phosphate rock, tungsten concentrate, vanadium, and values indicated by symbol W	XX	28,639	XX	38,300	XX	72,854	XX	92,081
Total	XX	106,206	XX	136,081	XX	208,558	XX	233,788
ILLINOIS								
Cement:								
Masonry ..... thousand short tons	80	2,483	88	2,901	69	3,228	W	W
Portland ..... do	1,571	33,124	1,572	36,064	1,460	41,023	1,374	42,756
Clays ..... do	[3] 1,716	[3] 3,314	[3] 1,758	[3] 3,613	[3] 1,587	[3] 3,744	1,366	3,249
Coal (bituminous) ..... do	65,523	402,481	61,572	413,309	58,215	582,010	59,537	871,377
Fluorspar ..... short tons	132,405	9,961	160,305	11,871	r 151,898	12,247	99,898	8,957
Gem stones	NA	2	NA	2	NA	2	NA	2
Lead (recoverable content of ores, etc.) ..... short tons	1,335	401	541	176	493	222	W	W
Natural gas ..... million cubic feet	1,194	334	1,688	573	1,436	574	1,440	1,008
Peat ..... thousand short tons	74	935	72	1,037	96	1,412	96	1,511
Petroleum (crude) ..... thousand 42-gallon barrels	34,874	121,013	30,669	132,490	27,553	244,395	26,067	273,182
Sand and gravel ..... thousand short tons	39,929	61,696	43,649	62,029	42,705	68,566	39,000	83,515
Stone ..... do	[4] 56,260	[4] 94,225	66,653	114,068	63,231	121,763	60,640	130,104
Zinc (recoverable content of ores, etc.) ..... short tons	11,378	4,039	5,250	2,169	4,104	2,947	W	W
Value of items that cannot be disclosed: Barite (1974–75), clay (fuller's earth), copper (1974), lime, natural gas liquids, silver, stone (dimension, 1972), tripoli, and values indicated by symbol W	XX	35,729	XX	45,306	XX	r 65,517	XX	74,937
Total	XX	769,737	XX	825,608	XX	r 1,147,650	XX	1,490,598
INDIANA								
Cement:								
Masonry ..... thousand short tons	W	W	W	W	W	W	343	12,263
Portland ..... do	W	W	W	W	W	W	2,185	63,077
Clays ..... do	[3] 1,419	[3] 2,465	1,436	2,568	1,092	1,947	1,094	1,961
Coal (bituminous) ..... do	25,949	144,688	25,253	153,136	23,726	198,410	25,124	280,130
Natural gas ..... million cubic feet	355	55	276	38	176	25	346	135

Peat thousand short tons	45	478	51	475	71	946	76	1,918
Petroleum (crude) thousand 42-gallon barrels	6,130	20,964	5,312	20,823	4,919	42,402	4,632	48,821
Sand and gravel thousand short tons	27,978	33,290	27,731	35,015	26,077	35,656	21,641	35,234
Stone do	27,511	50,919	[4] 32,288	[4] 57,652	[4] 31,031	[4] 64,106	28,947	68,850
Value of items that cannot be disclosed: Abrasive stone, clay (fire, 1972), gypsum, lime, stone (sandstone, 1973–74), and values indicated by symbol W	XX	69,749	XX	81,698	XX	97,198	XX	29,211
Total	XX	322,608	XX	351,405	XX	440,690	XX	541,600
IOWA								
Cement:								
Masonry thousand short tons	66	1,916	68	2,351	65	2,660	62	2,933
Portland do	2,458	49,635	2,688	59,574	2,424	64,156	2,258	73,786
Clays do	1,047	2,643	967	2,028	960	1,869	959	1,916
Coal (bituminous) do	851	4,138	601	3,279	590	4,591	622	6,891
Gem stones	NA	1	NA	W	NA	W	NA	W
Gypsum thousand short tons	1,380	5,714	1,470	r 6,324	1,397	7,142	1,208	6,546
Sand and gravel do	17,107	20,140	19,950	25,541	17,091	26,104	15,410	26,844
Stone do	27,457	48,642	31,541	56,918	32,342	66,119	30,336	73,732
Value of items that cannot be disclosed: Lime, peat, and values indicated by symbol W	XX	1,667	XX	2,785	XX	4,079	XX	3,092
Total	XX	134,496	XX	158,800	XX	176,720	XX	195,740
KANSAS								
Cement:								
Masonry thousand short tons	59	1,452	73	2,068	64	2,203	57	2,311
Portland do	1,889	35,432	2,026	42,172	1,940	46,940	1,832	55,033
Clays do	1,170	1,457	1,169	1,490	1,311	1,785	1,178	1,604
Coal (bituminous) do	1,227	7,835	1,086	7,979	718	5,463	479	9,481
Helium:								
Crude million cubic feet	2,278	27,336	1,539	18,468	W	W	W	W
High-purity do	384	8,064	416	8,736	499	11,477	497	11,928
Lime thousand short tons	9	172	10	199	28	535	W	W
Natural gas million cubic feet	889,268	127,859	893,118	138,521	886,782	147,206	843,625	145,103
Natural gas liquids:								
Natural gasoline thousand 42-gallon barrels	5,505	13,170	5,993	17,685	6,630	24,810	6,295	25,062
LP gases do	25,099	43,170	24,463	53,819	24,402	78,818	23,563	71,632
Petroleum (crude) do	73,744	259,578	66,227	281,465	61,691	490,984	59,106	561,508
Salt [7] thousand short tons	1,369	20,562	1,397	23,460	1,367	27,007	1,446	31,214
Sand and gravel do	11,591	10,920	13,261	12,663	11,687	13,388	10,866	13,467
Stone do	[4] 14,547	[4] 23,849	[4] 18,334	[4] 33,601	[4] 17,869	34,869	15,907	35,850
Value of items that cannot be disclosed: Diatomite (1974–75), gypsum, pumice, salt (brine), stone (dimension, 1972–73), and values indicated by symbol W	XX	3,741	XX	3,973	XX	3,913	XX	6,418
Total	XX	584,597	XX	646,299	XX	889,398	XX	970,611
KENTUCKY								
Clays [3] thousand short tons	920	1,406	1,083	1,961	848	1,477	778	1,483
Coal (bituminous) do	121,188	824,691	127,645	986,654	137,197	2,340,961	143,643	2,499,295

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
KENTUCKY—Continued								
Natural gas ____million cubic feet	63,648	$15,976	62,396	$21,839	71,876	$35,938	60,511	$32,676
Petroleum (crude) ____thousand 42-gallon barrels	9,702	32,599	8,687	34,515	7,837	68,340	7,556	84,520
Sand and gravel ____thousand short tons	8,485	11,967	10,331	14,627	8,710	12,887	8,924	14,466
Stone ____do	[4] 34,279	[4] 59,690	[4] 38,205	[4] 70,912	34,542	66,632	31,734	67,906
Zinc (recoverable content of ores, etc.) ____short tons	1,780	632	273	113	--	--	41	32
Value of items that cannot be disclosed: Cement, clay (ball), fluorspar, lead (1975), lime, natural gas liquids, and stone (quartzite and sandstone, 1972–73)	XX	29,949	XX	34,141	XX	36,975	XX	38,481
Total	XX	976,910	XX	1,164,762	XX	2,563,210	XX	2,738,859
LOUISIANA								
Clays ____thousand short tons	1,000	1,454	979	1,329	770	1,425	531	1,132
Lime ____do	908	19,614	897	16,801	796	17,665	485	12,484
Natural gas ____million cubic feet	7,972,678	1,626,426	8,242,423	1,846,303	7,753,631	2,380,365	7,090,645	2,999,179
Natural gas liquids:								
Natural gasoline and cycle products ____thousand 42-gallon barrels	52,842	167,768	47,906	167,037	35,860	234,954	31,808	178,930
LP gases ____do	99,233	185,660	102,701	253,671	108,439	423,996	103,714	392,039
Petroleum (crude) ____do	891,827	3,201,659	831,524	3,327,702	737,324	4,811,772	650,840	4,611,879
Salt ____thousand short tons	13,514	67,464	13,152	66,211	13,543	76,960	12,166	77,116
Sand and gravel ____do	18,920	26,996	13,748	21,165	12,341	27,781	14,587	35,990
Stone ____do	[4] 9,190	[4] 14,836	[4] 10,802	[4] 21,309	[4] 10,940	[4] 24,046	10,489	38,260
Sulfur (Frasch process) ____thousand long tons	3,765	W	3,329	W	3,426	W	2,672	W
Value of items that cannot be disclosed: Cement, gypsum, stone (miscellaneous, 1972–74), and values indicated by symbol W	XX	99,666	XX	98,082	XX	147,614	XX	166,266
Total	XX	5,411,543	XX	5,819,610	XX	8,146,578	XX	8,513,275
MAINE								
Clays ____thousand short tons	40	57	41	74	146	183	125	202
Copper ____short tons	1,220	1,249	1,107	1,317	1,522	2,353	2,024	2,599
Gem stones	NA	W	NA	W	NA	W	NA	W
Lead ____short tons	85	26	204	66	279	126	364	157
Peat ____thousand short tons	2	99	5	177	4	194	4	207
Sand and gravel ____do	11,818	7,535	13,583	10,304	8,755	10,673	9,875	11,403
Silver ____thousand troy ounces	16	27	W	W	W	W	W	W
Stone ____thousand short tons	1,078	2,996	1,212	3,329	1,491	4,255	[4] 1,253	[4] 3,741
Zinc (recoverable content of ores, etc.) ____short tons	5,820	2,066	19,640	8,115	10,425	7,485	8,318	6,488
Value of items that cannot be disclosed: Cement, stone (dimension, 1975), and values indicated by symbol W	XX	8,867	XX	10,111	XX	11,079	XX	11,944
Total	XX	22,922	XX	33,493	XX	36,348	XX	36,741

MARYLAND								
Clays [3] thousand short tons	1,104	2,121	897	1,973	884	2,066	580	1,450
Coal (bituminous) do	1,640	8,961	1,789	13,644	2,337	48,630	2,606	50,502
Gem stones	NA	8	NA	8	NA	8	NA	W
Lime thousand short tons	W	W	W	W	23	527	15	434
Natural gas million cubic feet	244	51	298	69	133	32	93	25
Peat thousand short tons	3	29	2	29	3	45	2	39
Sand and gravel do	12,594	26,557	12,845	29,625	11,690	29,386	11,786	29,477
Stone do	19,431	41,973	18,585	46,732	18,072	47,630	14,796	43,110
Value of items that cannot be disclosed: Cement, clay (ball), talc, soapstone, (1972–74), and values indicated by symbol W	XX	35,801	XX	39,827	XX	44,556	XX	39,882
Total	XX	115,501	XX	131,907	XX	172,880	XX	164,919
MASSACHUSETTS								
Clays thousand short tons	219	416	217	404	218	379	124	228
Gem stones	NA	5	NA	5	NA	5	NA	W
Lime thousand short tons	W	W	W	W	170	4,972	152	5,215
Peat do	W	W	2	78	3	85	W	W
Sand and gravel do	18,883	25,655	18,743	26,910	17,334	26,565	13,281	24,556
Stone do	7,990	23,500	8,580	28,738	8,103	30,103	7,170	28,681
Value of items that cannot be disclosed: Nonmetals and values indicated by symbol W	XX	2,852	XX	3,547	XX	--	XX	166
Total	XX	52,428	XX	59,682	XX	62,109	XX	58,846
MICHIGAN								
Cement:								
Masonry thousand short tons	250	5,959	247	6,185	217	6,309	183	6,429
Portland do	5,901	111,410	6,242	123,442	5,903	140,513	4,573	131,324
Clays do	2,514	3,715	2,151	3,304	2,161	4,074	1,818	3,580
Copper (recoverable content of ores, etc.) short tons	67,260	68,874	72,221	85,943	67,012	103,601	73,690	94,618
Gem stones	NA	8	NA	8	NA	8	NA	8
Gypsum thousand short tons	1,650	7,267	1,882	8,538	1,482	7,258	1,224	5,936
Iron ore (usable) thousand long tons, gross weight	12,692	177,461	12,389	180,194	11,602	213,598	14,089	339,113
Lime thousand short tons	1,509	22,753	1,545	26,055	1,528	30,036	1,434	36,540
Magnesium compounds from seawater and brine (except for metal) short tons, MgO equivalent	377,675	31,484	455,501	41,790	503,281	53,302	W	W
Natural gas million cubic feet	34,221	10,506	44,579	17,495	69,133	34,843	102,113	64,740
Natural gas liquids:								
Natural gasoline thousand 42-gallon barrels	395	1,097	372	1,189	466	3,089	656	3,294
LP gases do	833	2,274	691	2,529	849	5,383	1,348	5,945
Peat thousand short tons	219	2,190	232	2,172	244	3,811	245	3,206
Petroleum (crude) thousand 42-gallon barrels	12,990	41,556	14,614	59,413	18,021	154,746	24,420	262,352
Salt thousand short tons	4,358	50,761	4,818	53,732	4,445	62,055	4,020	68,353
Sand and gravel do	59,467	65,445	62,407	73,972	60,027	82,617	47,051	73,397
Silver (recoverable content of ores, etc.) thousand troy ounces	785	1,323	850	2,175	643	3,028	632	2,795
Stone thousand short tons	39,754	50,317	45,886	60,494	47,479	72,748	39,946	73,800
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, iodine, and value of items indicated by symbol W	XX	40,367	XX	40,392	XX	r 54,411	XX	116,223
Total	XX	694,767	XX	789,022	XX	r 1,035,430	XX	1,291,653

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
MINNESOTA								
Clays thousand short tons	[3] 167	[3] $251	[3] 156	[3] $233	W	W	W	W
Gem stones	NA	14	NA	14	NA	$14	NA	$14
Iron ore (usable) thousand long tons, gross weight	50,595	601,869	62,614	782,197	59,422	949,678	49,167	1,015,272
Manganiferous ore (5% to 35% Mn) short tons, gross weight	119,324	W	170,971	W	225,560	W	108,749	W
Peat thousand short tons	W	W	W	W	20	471	13	230
Sand and gravel do	36,792	33,454	37,935	39,438	36,720	42,370	33,398	45,214
Stone do	5,757	16,318	7,581	20,411	8,301	22,041	6,854	23,302
Value of items that cannot be disclosed: Abrasive stones, cement, clay (kaolin, 1972–73), lime, and values indicated by symbol W	XX	7,763	XX	10,492	XX	11,792	XX	13,056
Total	XX	659,669	XX	852,785	XX	1,026,366	XX	1,097,088
MISSISSIPPI								
Clays thousand short tons	1,919	7,837	2,075	9,082	2,013	10,468	1,592	10,605
Lime do	W	W	W	W	70	1,393	53	1,060
Natural gas million cubic feet	103,989	22,670	99,706	22,846	78,787	23,242	74,345	36,875
Petroleum (crude) thousand 42-gallon barrels	61,100	192,465	56,102	213,747	50,779	309,753	46,614	310,346
Sand and gravel thousand short tons	13,419	16,133	14,251	17,383	14,939	19,487	14,372	23,098
Stone do	1,135	1,199	[4] 760	[4] 809	1,719	2,572	1,629	2,730
Value of items that cannot be disclosed: Cement, magnesium compounds, natural gas liquids, stone (limestone, 1973), and values indicated by symbol W	XX	14,970	XX	17,871	XX	24,240	XX	25,295
Total	XX	255,274	XX	281,738	XX	391,155	XX	410,009
MISSOURI								
Barite thousand short tons	213	3,637	196	3,395	177	3,386	171	3,989
Cement:								
Masonry do	80	1,859	84	2,400	75	2,434	65	2,110
Portland do	4,277	80,898	4,582	99,858	4,229	106,985	3,962	116,260
Clays do	[3] 2,571	[3] 9,096	2,551	11,626	[3] 2,565	[3] 13,151	[3] 2,168	[3] 13,214
Coal (bituminous) do	4,551	23,667	4,658	24,999	4,623	29,383	5,638	48,054
Copper (recoverable content of ores, etc.) short tons	11,509	11,785	10,273	12,224	12,665	19,580	14,258	18,308
Iron ore (usable) thousand long tons, gross weight	2,695	W	2,630	W	1,866	W	2,273	W
Lead (recoverable content of ores, etc.) short tons	489,397	147,113	487,143	158,711	562,097	252,944	515,958	221,862
Lime thousand short tons	W	W	1,626	23,534	1,901	36,369	1,606	40,630
Natural gas million cubic feet	9	2	33	8	33	10	30	10
Petroleum (crude) thousand 42-gallon barrels	60	W	60	W	56	W	57	W
Phosphate rock thousand short tons	--	--	42	W	35	W	35	W
Sand and gravel do	10,082	14,806	10,879	16,950	10,933	19,462	9,752	18,216
Silver (recoverable content of ores, etc.) thousand troy ounces	1,972	3,322	2,058	5,264	2,387	11,244	2,524	11,161
Stone thousand short tons	42,473	[4] 63,219	49,304	79,921	50,626	90,204	46,988	95,535
Zinc (recoverable content of ores, etc.) short tons	61,923	21,983	82,350	34,027	91,987	66,047	74,867	58,396

Value of items that cannot be disclosed: Asphalt (native), clays (selected, except 1973), stone (dimension, 1972), and values indicated by symbol W	XX	70,430	XX	39,717	XX	39,850	XX	74,983
Total	XX	451,817	XX	512,634	XX	691,049	XX	722,728
MONTANA								
Antimony short tons	W	W	W	W	W	W	273	813
Clays [3] thousand short tons	304	1,590	219	1,298	298	2,189	223	1,878
Coal (bituminous and lignite) do	8,221	16,690	10,725	30,238	14,106	54,961	22,054	111,579
Copper (recoverable content of ores, etc.) short tons	123,110	126,064	132,466	157,634	131,131	202,728	87,959	112,940
Gem stones	NA	120	NA	150	NA	400	NA	400
Gold (recoverable content of ores, etc.) troy ounces	23,725	1,390	27,806	2,720	28,268	4,516	17,259	2,787
Iron ore (usable) thousand long tons, gross weight	9	W	13	W	30	W	18	W
Lead (recoverable content of ores, etc.) short tons	287	86	176	57	154	69	205	88
Lime thousand short tons	242	3,003	210	3,028	226	3,364	221	5,188
Manganese ore and concentrate (35% or more Mn) short tons, gross weight	578	W	239	W	--	--	--	--
Natural gas million cubic feet	33,474	4,117	56,175	13,240	54,873	13,883	40,734	17,638
Peat thousand short tons	1	W	1	W	W	W	1	51
Petroleum (crude) thousand 42-gallon barrels	33,904	103,924	34,620	115,423	34,554	229,802	32,844	257,169
Sand and gravel thousand short tons	10,116	17,149	11,694	13,819	4,242	6,126	4,127	6,963
Silver (recoverable content of ores, etc.) thousand troy ounces	3,325	5,603	4,350	11,127	3,512	16,542	2,617	11,565
Stone thousand short tons	4,074	5,627	5,054	9,559	[4] 3,115	[4] 6,242	[4] 3,130	[4] 6,753
Zinc (recoverable content of ores, etc.) short tons	12	4	73	30	136	98	110	86
Value of items that cannot be disclosed: Barite (1975), cement, clay (fire), fluorspar, gypsum, natural gas liquids, phosphate rock, stone (dimension, 1974–75), talc, tungsten ore and concentrate, vermiculite, and values indicated by symbol W	XX	22,309	XX	26,962	XX	33,881	XX	37,252
Total	XX	307,676	XX	385,285	XX	574,801	XX	573,150
NEBRASKA								
Clays thousand short tons	115	143	158	286	182	414	195	416
Gem stones	NA	11	NA	11	NA	W	NA	11
Lime thousand short tons	34	685	31	651	36	591	W	W
Natural gas million cubic feet	3,478	619	3,836	698	2,538	863	2,565	1,388
Petroleum (crude) thousand 42-gallon barrels	8,705	29,423	7,240	28,035	6,611	45,167	6,120	55,133
Sand and gravel	13,720	15,063	15,906	18,366	13,231	17,727	11,759	16,901
Stone do	4,251	7,645	5,368	10,958	4,630	10,364	4,242	10,322
Value of items that cannot be disclosed: Cement, natural gas liquids, pumice (1972), and values indicated by symbol W	XX	20,086	XX	21,816	XX	r 23,508	XX	27,734
Total	XX	73,675	XX	80,821	XX	98,634	XX	111,905
NEVADA								
Barite thousand short tons	317	2,659	549	4,691	761	8,115	916	11,006
Clays do	40	183	36	176	39	218	[3] 5	[3] 136
Copper (recoverable content of ores, etc.) short tons	101,119	103,545	93,702	111,505	84,101	130,021	81,210	104,274
Gem stones	NA	110	NA	142	NA	400	NA	2,814
Gold (recoverable content of ores, etc.) troy ounces	419,748	24,597	260,437	25,473	298,754	47,723	332,814	53,746
Gypsum thousand short tons	860	2,871	1,154	3,662	843	2,959	558	2,375

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
NEVADA—Continued								
Iron ore (usable) ......thousand long tons, gross weight..	W	W	119	W	139	W	109	$1,017
Lead (recoverable content of ores, etc.) ......short tons..	(5)	(5)	--	--	1,785	$803	2,976	1,280
Mercury ......76-pound flasks..	810	$177	698	$200	W	W	W	W
Petroleum (crude) ......thousand 42-gallon barrels..	100	W	96	W	129	W	115	W
Sand and gravel ......thousand short tons..	10,081	12,636	12,448	14,614	8,736	14,515	8,056	16,848
Silver (recoverable content of ores, etc.) ....thousand troy ounces..	595	1,003	624	1,595	872	4,108	1,609	7,111
Stone ......thousand short tons..	3,329	5,926	3,595	5,429	2,186	4,203	[4] 1,829	[4] 4,524
Tungsten ore and concentrate ......thousand pounds contained W..	157	W	150	377	132	537	33	152
Zinc (recoverable content of ores, etc.) ......short tons..	--	--	--	--	3,405	2,445	5,496	4,287
Value of items that cannot be disclosed: Antimony (1972–74), cement, clay (common, 1975), diatomite, fluorspar, lime, lithium minerals, magnesite, molybdenum, perlite, pumice, salt, stone (dimension, 1975), talc, and values indicated by symbol W	XX	27,995	XX	33,949	XX	41,829	XX	48,820
Total	XX	181,702	XX	201,813	XX	257,876	XX	258,390
NEW HAMPSHIRE								
Clays ......thousand short tons..	51	70	43	64	34	55	W	W
Gem stones	NA	42	NA	42	NA	42	W	W
Sand and gravel ......thousand short tons..	6,020	6,256	7,795	8,597	6,126	8,223	5,150	9,077
Stone ......do....	528	3,743	1,836	5,416	590	5,371	1,519	7,938
Value of items that cannot be disclosed	--	--	--	--	--	--	XX	92
Total	XX	10,111	XX	14,119	XX	13,691	XX	17,107
NEW JERSEY								
Clays ......thousand short tons..	212	856	183	666	104	524	67	372
Gem stones	NA	16	NA	16	NA	16	NA	16
Peat ......thousand short tons..	W	W	44	514	31	603	29	686
Sand and gravel ......do....	17,679	38,020	19,040	43,098	17,924	47,292	13,012	39,640
Stone [4] ......do....	15,223	42,044	15,902	45,585	15,749	52,456	11,821	42,381
Zinc (recoverable content of ores, etc.) ......short tons..	38,096	13,524	33,027	13,647	32,848	23,585	31,105	24,262
Value of items that cannot be disclosed: Lime (1972–73), magnesium compounds, manganiferous residuum, greensand marl, stone (dimension), titanium concentrate, and values indicated by symbol W	XX	8,261	XX	10,490	XX	16,272	XX	16,345
Total	XX	102,721	XX	114,016	XX	140,748	XX	123,702
NEW MEXICO								
Clays [3] ......thousand short tons..	65	108	88	169	55	317	44	61
Coal (bituminous) ......do....	8,248	29,794	9,069	31,862	9,392	W	8,785	W
Copper (recoverable content of ores, etc.) ......short tons..	168,034	172,067	204,742	243,643	196,585	303,920	146,263	187,802

Gem stones	NA	68	NA	70	NA	200	NA	200
Gold (recoverable content of ores, etc.) ---troy ounces	14,897	873	13,864	1,356	15,427	2,464	15,049	2,430
Gypsum ---thousand short tons	W	W	255	1,220	157	532	W	W
Helium (high-purity) ---million cubic feet	--	--	--	--	--	--	W	W
Iron ore (usable) ---thousand long tons, gross weight	W	W	5	114	6	135	W	W
Lead (recoverable content of ores, etc.) ---short tons	3,582	1,077	2,556	833	2,364	1,064	1,931	830
Lime ---thousand short tons	28	W	44	793	58	1,679	W	W
Manganiferous ore (5% to 35% Mn) ---short tons, gross weight	27,837	W	32,084	W	47,348	W	49,976	W
Mica, scrap ---thousand short tons	14	W	10	82	12	60	W	W
Natural gas ---million cubic feet	1,216,061	225,420	1,218,749	287,889	r 1,244,779	390,861	1,217,430	493,059
Natural gas liquids:								
Natural gasoline and cycle products ---thousand 42-gallon barrels	10,338	29,970	9,848	32,449	9,713	53,545	9,194	45,292
LP gases ---do	27,859	45,689	29,652	74,427	30,271	120,781	30,214	122,065
Peat ---thousand short tons	2	46	3	50	4	111	--	--
Perlite ---do	476	5,698	478	5,024	480	6,306	429	6,400
Petroleum (crude) ---thousand 42-gallon barrels	110,525	376,778	100,986	414,041	98,695	712,578	95,063	788,073
Potassium salts ---thousand short tons, K_2O equivalent	2,296	91,115	2,168	91,996	2,102	128,588	2,081	179,924
Pumice ---thousand short tons	311	809	339	1,001	471	1,466	397	1,280
Salt ---do	W	W	W	W	167	W	147	1,048
Sand and gravel ---do	7,600	8,553	10,641	15,753	7,413	10,605	6,220	13,798
Silver (recoverable content of ores, etc.) ---thousand troy ounces	1,017	1,713	1,111	2,843	1,195	5,628	792	3,501
Stone ---thousand short tons	2,768	5,499	2,830	5,894	[4] 3,531	[4] 8,359	2,197	4,683
Tin ---long tons	--	--	W	W	W	W	W	W
Uranium (recoverable content U_3O_8) ---thousand pounds	10,808	68,091	9,286	60,356	9,971	104,693	10,393	127,829
Zinc (recoverable content of ores, etc.) ---short tons	12,735	4,521	12,327	5,094	13,784	9,897	11,015	8,592
Value of items that cannot be disclosed: Carbon dioxide, cement, clay (fire), fluorspar (except 1973), molybdenum, stone (dimension, 1974), vanadium, and values indicated by symbol W	XX	29,403	XX	29,631	XX	77,755	XX	104,674
Total	XX	1,097,292	XX	1,306,590	XX	1,941,544	XX	2,091,541

NEW YORK

Clays [3] ---thousand short tons	1,601	1,919	1,799	2,146	1,451	2,348	817	1,561
Emery ---short tons	2,883	W	2,883	W	W	W	W	W
Gem stones	NA	16	NA	16	NA	16	NA	16
Gypsum ---thousand short tons	486	3,079	525	3,369	364	2,942	W	W
Lead (recoverable content of ores, etc.) ---short tons	1,089	327	2,304	751	3,076	1,384	3,027	1,302
Mercury ---76-pound flasks	W	W	--	--	W	W	W	W
Natural gas ---million cubic feet	3,679	1,199	4,539	1,590	4,990	2,745	7,628	5,645
Peat ---thousand short tons	15	200	11	166	18	181	22	377
Petroleum (crude) ---thousand 42-gallon barrels	1,018	4,897	967	5,412	896	9,538	875	10,693
Salt ---thousand short tons	5,604	43,866	5,202	42,364	6,464	57,706	5,978	57,344
Sand and gravel ---do	26,722	36,952	29,544	41,396	30,614	46,652	22,158	44,064
Silver (recoverable content of ores, etc.) ---thousand troy ounces	25	42	54	139	64	304	56	248
Stone ---thousand short tons	38,138	77,825	44,393	94,693	38,207	87,724	31,713	80,929
Zinc (recoverable content of ores, etc.) ---short tons	60,749	21,566	81,455	33,657	93,077	66,829	76,612	59,757
Value of items that cannot be disclosed: Cement, clay (ball), garnet (abrasive), iron ore, lime, talc, titanium concentrate, wollastonite, and values indicated by symbol W	XX	128,566	XX	150,167	XX	162,295	XX	135,792
Total	XX	320,454	XX	375,866	XX	440,573	XX	397,728

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
NORTH CAROLINA								
Clays [3] ----thousand short tons	3,862	$4,473	4,109	$5,057	3,422	$4,648	2,582	$4,094
Feldspar ----short tons	439,838	6,030	523,595	8,820	650,684	11,147	483,401	8,070
Gem stones	NA	32	NA	40	NA	50	NA	50
Mica:								
Scrap ----thousand short tons	91	2,942	106	4,423	76	3,679	75	3,265
Sheet ----pounds	--	--	--	--	W	W	W	W
Sand and gravel ----thousand short tons	12,823	13,812	15,897	19,327	12,784	20,844	8,169	15,610
Stone ----do	32,297	62,741	38,782	80,065	34,762	75,142	28,308	69,327
Talc and pyrophyllite ----short tons	89,334	594	95,833	1,094	110,978	993	58,514	985
Value of items that cannot be disclosed: Asbestos, cement, clay (kaolin), iron ore (1972–74), lithium minerals, olivine, phosphate rock, and values indicated by symbol W	XX	24,896	XX	28,104	XX	39,366	XX	51,479
Total	XX	115,520	XX	146,930	XX	155,869	XX	152,880
NORTH DAKOTA								
Coal (lignite) ----thousand short tons	6,632	13,416	6,906	14,328	7,463	16,351	8,515	27,010
Gem stones	NA	2	NA	2	NA	2	NA	2
Natural gas ----million cubic feet	32,472	5,455	27,703	5,457	31,206	6,210	24,786	5,701
Peat ----short tons	--	--	--	--	240	W	W	W
Petroleum (crude) ----thousand 42-gallon barrels	20,624	67,647	20,235	78,916	19,697	119,022	20,452	149,705
Sand and gravel ----thousand short tons	6,681	5,757	6,011	6,021	4,991	6,211	5,636	8,133
Stone ----do	W	W	W	W	35	115	30	153
Value of items that cannot be disclosed: Clays, lime, natural gas liquids, pumice (1972), salt, and values indicated by symbol W	XX	5,809	XX	7,129	XX	11,516	XX	10,800
Total	XX	98,086	XX	111,853	XX	159,427	XX	201,504
OHIO								
Cement:								
Masonry ----thousand short tons	161	4,684	176	5,641	158	5,227	136	4,576
Portland ----do	2,968	57,953	3,456	73,362	2,884	73,815	2,364	70,268
Clays ----do	4,125	11,273	4,732	12,456	4,325	13,488	3,451	11,822
Coal (bituminous) ----do	50,967	303,819	45,783	338,792	45,409	559,519	46,770	766,875
Gem stones	NA	8	NA	8	NA	8	NA	W
Lime ----thousand short tons	4,413	75,569	4,389	77,028	4,171	93,695	3,482	95,136
Natural gas ----million cubic feet	89,995	35,271	93,610	39,786	r 92,055	44,371	84,960	59,982
Peat ----thousand short tons	4	67	4	64	5	74	4	99
Petroleum (crude) ----thousand 42-gallon barrels	9,358	35,179	8,796	44,690	9,088	89,348	9,578	113,917
Salt ----thousand short tons	6,147	47,710	4,657	41,643	5,029	49,089	5,083	54,651
Sand and gravel ----do	43,506	59,932	48,987	69,982	41,353	68,258	37,195	68,552
Stone ----do	48,498	90,821	[4] 55,107	[4] 98,009	[4] 51,709	[4] 105,098	46,303	108,580
Value of items that cannot be disclosed: Abrasive stones, gypsum, stone (dimension, 1973–74), and values indicated by symbol W	XX	2,462	XX	5,518	XX	5,680	XX	1,996
Total	XX	724,748	XX	806,979	XX	1,107,670	XX	1,356,454

OKLAHOMA								
Clays ----thousand short tons--	[3] 938	[3] 1,398	[3] 1,298	[3] 1,871	1,289	2,105	995	1,701
Coal (bituminous) ----do----	2,624	19,112	2,183	16,779	2,356	24,759	2,872	47,946
Gypsum ----do----	1,196	3,888	1,429	5,796	1,225	5,622	1,028	4,835
Helium:								
High-purity ----million cubic feet--	176	6,160	181	6,335	169	5,915	224	7,411
Crude ----do----	163	1,956	115	1,380	134	1,608	148	1,776
Lead (recoverable content of ores, etc.) ----short tons--	--	--	--	--	W	W	--	--
Natural gas ----million cubic feet--	1,806,887	294,523	1,770,980	334,110	1,638,942	458,904	1,605,410	513,731
Natural gas liquids:								
Natural gasoline and cycle products --thousand 42-gallon barrels--	14,559	42,709	14,674	49,070	12,581	84,638	10,835	63,383
LP gases ----do----	27,148	57,011	29,044	95,264	31,231	166,461	29,640	140,197
Petroleum (crude) ----do----	207,633	709,033	191,204	723,273	177,785	1,277,076	163,123	1,389,164
Pumice ----thousand short tons--	W	W	1	W	W	W	1	W
Salt ----do----	W	W	5	36	W	W	W	W
Sand and gravel ----do----	7,901	11,138	12,154	14,941	8,708	13,772	9,591	16,749
Stone ----do----	19,448	26,574	22,316	34,999	22,228	36,599	20,111	36,840
Zinc (recoverable content of ores, etc.) ----short tons--	W	W	--	--	W	W	--	--
Value of items that cannot be disclosed: Cement, clay (bentonite, 1972–73), copper, feldspar (1974), lime, silver, tripoli, and values indicated by symbol W ----	XX	37,296	XX	39,772	XX	r 45,142	XX	43,362
Total ----	XX	1,210,798	XX	1,323,626	XX	r 2,122,601	XX	2,267,095
OREGON								
Clays ----thousand short tons--	151	238	168	291	140	243	120	214
Copper ----short tons--	W	W	W	W	W	W	W	W
Diatomite ----do----	W	W	W	W	W	W	W	W
Gem stones ----	NA	793	NA	700	NA	500	NA	500
Gold (recoverable content of ores, etc.) ----troy ounces--	W	W	W	W	W	W	W	W
Lead ----short tons--	--	--	--	--	W	W	W	W
Lime ----thousand short tons--	96	2,129	106	2,552	98	2,818	96	3,281
Mercury ----76-pound flasks--	--	--	W	W	--	--	--	--
Nickel (content of ore and concentrate) ----short tons--	16,864	W	18,272	W	16,618	W	16,987	W
Pumice ----thousand short tons--	W	W	1,171	2,013	915	1,887	1,470	3,937
Sand and gravel ----do----	24,489	34,981	22,802	32,751	18,558	30,948	16,527	29,596
Silver (recoverable content of ores, etc.) ----thousand troy ounces--	2	4	1	3	9	42	W	W
Stone ----thousand short tons--	10,915	18,380	13,411	21,843	23,353	43,406	21,275	40,321
Value of items that cannot be disclosed: Cement, emery (1973, 1975), talc and soapstone, tungsten (1972), and values indicated by symbol W ----	XX	19,991	XX	21,424	XX	24,076	XX	28,155
Total ----	XX	76,516	XX	81,577	XX	103,920	XX	106,004
PENNSYLVANIA								
Cement:								
Masonry ----thousand short tons--	451	12,401	490	14,443	404	14,642	357	14,640
Portland ----do----	8,214	156,008	8,563	171,653	7,448	191,594	5,815	168,220
Clays ----do----	2,682	15,829	[3] 2,975	[3] 16,664	[3] 2,732	[3] 16,496	[3] 1,945	[3] 13,672

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
PENNSYLVANIA—Continued								
Coal:								
Anthracite ----thousand short tons--	7,106	$85,251	6,830	$90,260	6,617	$144,695	6,203	$198,481
Bituminous ----do----	75,939	694,267	76,403	786,792	80,462	1,637,394	84,137	2,111,009
Copper (recoverable content of ores, etc.) ----short tons--	2,611	2,673	1,845	2,195	--	--	--	--
Gem stones ----	NA	9	NA	9	NA	9	NA	9
Lime ----thousand short tons--	1,891	33,802	2,260	40,949	2,080	50,147	1,940	60,047
Mica, scrap ----do----	W	W	--	--	--	--	W	W
Natural gas ----million cubic feet--	73,958	22,389	78,514	32,976	82,637	36,360	84,676	57,156
Peat ----thousand short tons--	22	320	28	411	30	515	27	488
Petroleum (crude) ----thousand 42-gallon barrels--	3,441	16,414	3,282	18,440	3,478	36,220	3,264	39,647
Sand and gravel ----thousand short tons--	18,757	36,804	20,576	42,830	18,071	45,181	17,401	48,742
Stone ----do----	67,307	124,340	78,564	150,346	73,092	159,615	60,177	149,670
Zinc (recoverable content of ores, etc.) ----short tons--	18,344	6,512	18,857	7,792	20,288	14,567	21,090	16,450
Value of items that cannot be disclosed: Clay (kaolin, except 1972), iron ore, natural gas liquids, tripoli, and values indicated by symbol W ----	XX	24,466	XX	26,140	XX	r 26,993	XX	29,607
Total ----	XX	1,231,485	XX	1,401,900	XX	r 2,374,428	XX	2,907,838
RHODE ISLAND								
Sand and gravel ----thousand short tons--	2,079	3,336	2,429	3,095	2,784	4,605	2,910	5,070
Stone ----do----	[4] 329	[4] 23	W	W	W	W	293	1,125
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W ----	XX	932	XX	1,245	XX	1,377	XX	3
Total ----	XX	4,291	XX	4,340	XX	5,982	XX	6,198
SOUTH CAROLINA								
Clays ----thousand short tons--	2,221	11,268	[3] 2,250	[3] 12,877	[3] 2,297	[3] 13,765	[3] 1,698	[3] 12,828
Gem stones ----	--	--	NA	5	NA	5	NA	5
Mica (scrap) ----thousand short tons--	W	W	W	W	W	252	7	318
Peat ----do----	W	W	14	W	18	W	18	W
Sand and gravel ----do----	7,916	12,121	8,179	12,628	7,380	13,054	7,363	14,128
Stone ----do----	12,482	21,819	14,985	24,280	[4] 12,242	[4] 21,719	13,836	30,082
Value of items that canot be disclosed: Cement, clay (fuller's earth, 1973–75), feldspar (1972), stone (limestone, 1974), vermiculite, and values indicated by symbol W ----	XX	37,105	XX	38,571	XX	56,376	XX	58,106
Total ----	XX	82,313	XX	88,361	XX	105,171	XX	115,467
SOUTH DAKOTA								
Clays [3] ----thousand short tons--	185	156	201	181	190	202	187	185
Feldspar ----short tons--	25,000	400	W	W	W	W	W	W
Gem stones ----	NA	42	NA	42	NA	42	NA	42

Gold (recoverable content of ores, etc.) ---troy ounces--	407,430	23,875	375,575	34,974	343,723	54,906	304,935	49,244
Gypsum ---thousand short tons--	24	43	W	W	32	135	23	60
Lime ---do---	W	W	63	1,206	94	2,059	W	W
Mica (scrap) ---do---	W	W	--	--	W	W	W	W
Petroleum (crude) ---thousand 42-gallon barrels--	219	574	275	988	494	3,283	472	5,996
Sand and gravel ---thousand short tons--	12,748	14,793	13,963	16,587	9,028	9,720	6,481	8,668
Silver (recoverable content of ores, etc.) ---thousand troy ounces--	100	168	72	184	62	294	68	299
Stone ---thousand short tons--	2,665	10,864	2,745	11,607	2,968	14,231	2,647	15,350
Value of items that cannot be disclosed: Beryllium concentrate (1972, 1975), cement, clay (bentonite), iron ore (1974–75), natural gas liquids (1974–75), uranium (1972), vanadium (1972), and values indicated by symbol W ---	XX	14,535	XX	15,370	XX	r 17,938	XX	21,977
Total ---	XX	65,450	XX	81,139	XX	r 102,810	XX	101,821
TENNESSEE								
Barite ---thousand short tons--	W	W	W	W	W	W	13	260
Cement:								
Masonry ---do---	176	4,104	201	7,908	154	4,706	138	4,778
Portland ---do---	1,695	37,176	1,711	42,402	1,525	43,339	1,136	37,866
Clays [3] ---do---	1,718	7,719	1,719	9,083	1,638	9,776	1,310	9,008
Coal (bituminous) ---do---	11,260	81,386	8,219	66,827	7,541	135,874	8,206	140,293
Copper (recoverable content of ores, etc.) ---short tons--	11,310	11,581	8,500	10,115	6,304	9,745	10,041	12,893
Gold (recoverable content of ores, etc.) ---troy ounces--	176	10	68	7	18	3	W	W
Lime ---thousand short tons--	W	W	W	W	136	3,449	106	3,735
Natural gas ---million cubic feet--	25	8	20	6	17	6	27	12
Petroleum (crude) ---thousand 42-gallon barrels--	198	W	201	W	769	7,256	682	7,849
Phosphate rock ---thousand short tons--	2,154	10,732	2,512	12,799	2,411	18,465	2,291	28,803
Sand and gravel ---do---	10,839	15,328	12,010	20,145	10,702	19,476	10,909	22,102
Silver (recoverable content of ores, etc.) ---thousand troy ounces--	83	141	73	187	20	94	54	238
Stone ---thousand short tons--	35,942	55,512	42,742	71,116	41,720	75,547	39,938	83,437
Zinc (recoverable content of ores, etc.) ---short tons--	101,722	36,111	64,172	26,516	85,671	61,512	83,293	64,968
Value of items that cannot be disclosed: Clay (fuller's earth), pyrites, and values indicated by symbol W ---	XX	10,006	XX	8,579	XX	6,360	XX	8,526
Total ---	XX	269,814	XX	275,690	XX	395,608	XX	424,768
TEXAS								
Cement:								
Masonry ---thousand short tons--	217	5,812	234	6,606	195	6,438	181	7,089
Portland ---do---	7,813	171,642	8,320	189,368	7,739	207,706	7,195	224,804
Clays ---do---	5,175	11,554	5,667	13,115	5,315	13,677	4,248	13,411
Coal (lignite) ---do---	4,045	W	6,944	W	7,684	W	11,002	W
Gem stones ---	NA	163	NA	163	NA	160	NA	160
Gypsum ---thousand short tons--	1,542	5,284	1,616	6,469	1,365	5,276	1,094	4,277
Helium, crude ---million cubic feet--	1,026	12,312	904	10,848	35	420	36	432
Iron ore ---thousand long tons--	W	W	W	W	W	W	601	W
Lime ---thousand short tons--	1,631	22,181	1,677	26,887	1,835	39,644	1,735	46,179
Natural gas ---million cubic feet--	8,657,840	1,419,886	8,513,850	1,735,221	8,170,798	2,541,118	7,485,764	3,885,112
Natural gas liquids:								
Natural gasoline and cycle products---thousand 42-gallon barrels--	92,437	294,163	92,743	347,393	88,316	629,529	78,835	479,700
LP gases ---do---	226,624	428,319	221,686	589,685	213,756	1,004,653	212,635	965,363

See footnotes at end of table.

Table 6.—Mineral production [1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
TEXAS—Continued								
Perlite ____ short tons__	2,391	$24	602	W	--	--	--	--
Petroleum (crude) ____ thousand 42-gallon barrels__	1,301,685	4,536,077	1,294,671	$5,157,623	1,262,126	$8,773,003	1,221,929	$9,336,570
Pumice ____ thousand short tons__	W	W	--	--	--	--	--	--
Salt ____ do____	9,744	r 36,544	10,354	45,350	11,379	51,296	8,560	42,119
Sand and gravel ____ do____	35,151	56,328	38,546	60,706	42,466	81,364	38,649	87,106
Stone ____ do____	49,314	[4] 66,573	62,574	91,379	[4] 63,074	[4] 109,758	57,985	106,554
Sulfur (Frasch process) ____ thousand long tons__	3,847	W	4,109	W	4,473	W	3,406	W
Talc and soapstone ____ short tons__	221,022	1,262	232,514	1,246	188,262	1,310	129,626	795
Value of items that cannot be disclosed: Asphalt (native), fluorspar, graphite, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1972–73), sodium sulfate, stone (dimension, 1972, 1974), uranium, and values indicated by symbol W ____	XX	143,427	XX	160,435	XX	245,792	XX	330,260
Total ____	XX	7,211,551	XX	8,442,494	XX	13,711,144	XX	15,529,931
UTAH								
Carbon dioxide, natural ____ thousand cubic feet__	61,103	4	80,490	6	93,751	6	108,941	8
Clays ____ thousand short tons__	[3] 266	[3] 790	[3] 243	[3] 771	232	953	[3] 220	[3] 548
Coal (bituminous) ____ do____	4,802	42,868	5,500	61,566	5,858	71,699	6,961	138,134
Copper (recoverable content of ores, etc.) ____ short tons__	259,507	265,735	256,589	305,341	230,593	356,497	177,155	227,467
Fluorspar ____ do____	2,977	84	4,778	144	2,967	98	9,542	389
Gem stones ____	NA	95	NA	95	NA	100	NA	100
Gold (recoverable content of ores, etc.) ____ troy ounces__	362,413	21,237	307,080	30,035	254,909	40,719	189,620	30,622
Gypsum ____ thousand short tons__	W	W	231	1,134	248	1,076	247	1,457
Iron ore (usable) ____ thousand long tons, gross weight__	1,788	W	1,986	13,581	1,808	14,016	1,334	10,399
Lead (recoverable content of ores, etc.) ____ short tons__	20,706	6,224	13,733	4,474	10,510	4,729	12,679	5,452
Lime ____ thousand short tons__	171	4,216	185	3,804	176	4,911	161	4,540
Natural gas ____ million cubic feet__	39,474	6,711	42,715	8,159	50,522	20,815	55,354	26,570
Natural gas liquids:								
Natural gasoline and cycle products__ thousand 42-gallon barrels__	458	1,406	W	W	W	W	W	W
LP gases ____ do____	1,742	2,787	W	W	W	W	W	W
Petroleum (crude) ____ do____	26,570	80,773	32,656	117,743	39,363	279,858	42,301	348,131
Pumice ____ thousand short tons__	14	29	42	57	15	19	17	23
Salt ____ do____	660	4,955	717	6,913	771	7,321	631	7,717
Sand and gravel ____ do____	14,619	17,071	15,410	15,986	11,578	12,985	10,159	14,342
Silver (recoverable content of ores, etc.) ____ thousand troy ounces__	4,300	7,245	3,619	9,257	3,208	15,109	2,822	12,472
Stone ____ thousand short tons__	3,384	6,005	2,848	6,318	2,869	6,410	2,486	6,167
Uranium (recoverable content (U_3O_8)) ____ thousand pounds__	1,496	9,425	1,961	12,745	W	W	W	W
Vanadium (recoverable in ore and concentrate) ____ short tons__	188	W	142	W	W	W	W	W
Zinc (recoverable content of ores, etc.) ____ do____	21,853	7,758	16,800	6,942	12,619	9,060	19,640	15,319
Value of items that cannot be disclosed: Asphalt (gilsonite), beryl concentrate, cement, clay (kaolin, except 1974), magnesium chloride, magnesium compounds, molybdenum, phosphate rock,								

potassium salts, sodium sulfate, tungsten, and values indicated by symbol W	XX	57,391	XX	69,274	XX	105,664	XX	116,550
Total	XX	542,809	XX	r 674,354	XX	952,045	XX	966,407
VERMONT								
Peat ---thousand short tons	(5)	1	(5)	2	(5)	4	(5)	W
Sand and gravel ---do	3,302	3,214	4,041	3,581	2,394	3,588	2,356	3,693
Stone ---do	3,300	26,170	1,871	19,523	1,932	21,630	1,224	15,718
Talc ---short tons	180,239	1,326	251,087	1,497	W	W	230,973	1,918
Value of items that cannot be disclosed: Asbestos, other nonmetals, and values indicated by symbol W	XX	4,157	XX	4,763	XX	r 8,723	XX	7,450
Total	XX	34,868	XX	29,366	XX	r 33,945	XX	28,779
VIRGINIA								
Clays ---thousand short tons	1,634	1,783	1,646	1,886	1,957	2,614	819	1,152
Coal (bituminous) ---do	34,028	344,061	33,961	377,679	34,326	856,099	35,510	1,081,587
Gem stones	NA	13	NA	13	NA	13	NA	13
Lead (recoverable content of ores, etc.) ---short tons	3,441	1,034	2,637	859	3,106	1,398	2,551	1,097
Lime ---thousand short tons	758	11,739	782	12,205	895	18,929	705	20,192
Natural gas ---million cubic feet	2,787	892	5,101	1,688	7,096	3,619	6,723	3,462
Petroleum (crude) ---thousand 42-gallon barrels	(5)	(5)	--	--	3	W	3	W
Sand and gravel ---thousand short tons	14,085	21,696	14,511	26,246	14,314	29,270	9,895	24,776
Soapstone ---short tons	W	W	4,600	12	W	W	W	W
Stone ---thousand short tons	39,986	74,090	43,895	82,719	44,176	95,988	35,384	84,204
Zinc (recoverable content of ores, etc.) ---short tons	16,789	5,960	16,683	6,894	17,195	12,346	15,151	11,818
Value of items that cannot be disclosed: Aplite, cement, gypsum, kyanite, salt (1972), silver (1975), and values indicated by symbol W	XX	28,523	XX	35,201	XX	r 36,293	XX	33,673
Total	XX	489,791	XX	545,402	XX	r 1,056,569	XX	1,261,974
WASHINGTON								
Cement:								
Masonry ---thousand short tons	6	170	6	169	6	193	5	209
Portland ---do	1,239	26,848	1,194	26,651	1,377	36,347	1,147	40,666
Clays [3] ---do	264	584	287	664	269	698	290	778
Coal (bituminous) ---do	2,635	17,424	3,270	21,440	3,913	W	3,743	W
Gem stones	NA	163	NA	160	NA	160	NA	160
Gypsum ---thousand short tons	5	13	W	W	W	W	W	W
Lead (recoverable content of ores, etc.) ---short tons	2,567	772	2,217	722	1,299	585	W	W
Peat ---thousand short tons	18	89	21	110	14	85	13	98
Pumice ---do	W	W	1	1	(5)	1	--	--
Sand and gravel ---do	23,065	26,069	27,935	30,132	22,842	35,030	19,069	32,990
Silver (recoverable content of ores, etc.) ---thousand troy ounces	221	372	W	W	W	W	W	W
Stone ---thousand short tons	14,712	[4] 23,764	11,384	19,284	15,095	24,483	7,920	18,754
Zinc (recoverable content of ores, etc.) ---short tons	6,483	2,301	6,378	2,635	6,909	4,960	W	W
Values of items that cannot be disclosed: Clay (fire), copper, diatomite, gold, lime, olivine, stone (dimension, 1972), talc, tungsten, uranium, and values indicated by symbol W	XX	11,237	XX	12,695	XX	r 41,388	XX	64,850
Total	XX	109,806	XX	114,663	XX	r 143,930	XX	158,505

See footnotes at end of table.

Table 6.—Mineral production[1] in the United States, by State—Continued

Mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
WEST VIRGINIA								
Clays[3] ____thousand short tons__	274	$403	348	$516	339	$520	278	$439
Coal (bituminous) ____do____	123,743	1,275,813	115,448	1,340,338	102,462	2,218,418	109,283	3,206,951
Gem stones ____	NA	2	NA	2	NA	2	NA	2
Lime ____thousand short tons__	W	W	W	W	128	2,315	W	W
Natural gas ____million cubic feet__	214,951	64,485	208,676	64,481	202,306	66,356	154,484	57,005
Petroleum (crude) ____thousand 42-gallon barrels__	2,677	12,047	2,385	11,965	2,665	27,058	2,479	29,712
Salt ____thousand short tons__	1,232	5,963	1,217	6,082	1,201	6,296	972	4,672
Sand and gravel ____do____	5,765	15,031	5,893	16,257	5,382	16,018	5,068	17,872
Stone ____do____	[4] 11,649	[4] 21,293	[4] 11,732	[4] 22,821	10,954	22,308	[4] 10,583	24,333
Value of items that cannot be disclosed: Cement, clay (fire), natural gas liquids, stone (dimension, 1972–73), and values indicated by symbol W ____	XX	35,595	XX	40,583	XX	[r] 43,886	XX	49,226
Total ____	XX	1,430,632	XX	1,503,045	XX	2,403,177	XX	3,390,212
WISCONSIN								
Clays ____thousand short tons__	4	7	2	3	2	4	2	4
Gem stones ____	NA	1	NA	1	NA	1	NA	1
Iron ore (usable) ____thousand long tons, gross weight__	887	W	956	W	899	W	791	W
Lead (recoverable content of ores, etc.) ____short tons__	757	228	844	275	1,285	578	W	W
Lime ____thousand short tons__	263	5,009	310	6,004	311	6,764	296	8,604
Peat ____do____	2	179	2	208	W	W	11	502
Sand and gravel ____do____	36,430	31,324	40,250	43,647	28,850	34,577	30,057	40,580
Stone ____do____	19,394	29,681	23,818	36,917	22,443	40,912	20,566	40,156
Zinc (recoverable content of ores, etc.) ____short tons__	6,873	2,440	8,672	3,583	8,737	6,273	W	W
Value of items that cannot be disclosed: Abrasive stones, cement, copper (1974–75), silver (1974–75), and values indicated by symbol W ____	XX	20,484	XX	23,701	XX	25,654	XX	42,413
Total ____	XX	89,353	XX	114,339	XX	114,763	XX	132,260
WYOMING								
Clays ____thousand short tons__	1,873	18,509	2,343	24,043	2,511	29,339	2,582	36,046
Coal (bituminous) ____do____	10,928	40,898	14,886	60,939	20,703	103,915	23,804	160,447
Feldspar ____short tons__	W	W	2,588	56	W	W	W	W
Gem stones ____	NA	142	NA	142	NA	140	NA	140
Gypsum ____thousand short tons__	W	W	312	1,348	315	960	271	902
Iron ore (usable) ____thousand long tons, gross weight__	2,030	W	2,070	W	2,105	W	2,039	26,792
Lime ____thousand short tons__	W	W	30	548	29	464	W	W
Natural gas ____million cubic feet__	375,059	60,760	357,731	64,749	326,657	80,031	316,123	106,533
Natural gas liquids:								
Natural gasoline ____thousand 42-gallon barrels__	3,015	8,951	3,351	10,647	2,933	18,577	2,909	17,694
LP gases ____do____	7,691	15,536	7,237	22,507	6,804	31,707	6,061	29,578
Petroleum (crude) ____do____	140,011	432,071	141,914	541,820	139,997	914,360	135,943	983,785

Sand and gravel ---------thousand short tons--	9,098	14,916	6,201	11,635	5,532	9,508	4,328	10,746
Stone ---------do----	3,549	5,768	3,191	6,716	2,384	[4] 5,989	2,882	7,618
Uranium (recoverable content (U_3O_8) ---------thousand pounds--	8,544	53,827	10,134	65,868	7,449	78,213	6,862	84,406
Value of items that cannot be disclosed: Cement, phosphate rock, pumice (1972–73), sodium carbonate, and values indicated by symbol W ----------	XX	95,365	XX	117,565	XX	163,997	XX	179,751
Total ----------	XX	746,743	XX	928,583	XX	1,437,200	XX	1,644,438

[r] Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Excludes certain cement, included with "Value of items that cannot be disclosed."
[3] Excludes certain clays, included with "Value of items that cannot be disclosed."
[4] Excludes certain stones, included with "Value of items that cannot be disclosed."
[5] Less than ½ unit.
[6] Total of items listed.
[7] Excludes salt in brine, included with "Value of items that cannot be disclosed."

Table 7.—Mineral production[1] in the islands administered by the United States

Area and mineral	1972 Quantity	1972 Value (thousands)	1973 Quantity	1973 Value (thousands)	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
American Samoa:								
Pumice thousand short tons	--	--	37	$214	27	$183	15	$15
Stone do	49	$414	63	152	50	122	34	147
Total	XX	414	XX	366	XX	305	XX	162
Guam: Stone thousand short tons	831	1,983	1,246	3,139	798	1,444	781	1,837
Virgin Islands: Stone do	726	2,255	664	2,860	638	3,869	253	1,813

XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 8.—Mineral production[1] in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1972 Quantity	1972 Value	1973 Quantity	1973 Value	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Cement	1,946	31,756	2,062	41,203	1,881	70,277	1,582	60,968
Clays	361	382	464	473	291	332	341	440
Lime	42	1,776	42	2,215	39	2,923	28	2,231
Salt	29	580	29	580	29	624	27	639
Sand and gravel	7,478	21,237	7,480	21,243	NA	NA	NA	NA
Stone	13,504	32,793	15,647	41,857	14,362	41,640	13,595	47,515
Total	XX	88,524	XX	107,571	XX	[2] 115,796	XX	[2] 111,793

NA Not available. XX Not applicable.
[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Total does not include value of items withheld or not available.

Table 9.—U.S. exports of principal minerals and products

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude ____short tons__	r 207,829	$155,817	185,850	$134,064
Scrap ____do____	80,158	33,043	65,747	29,085
Plates, sheets, bars, etc ____do____	216,030	247,976	171,008	228,684
Castings and forgings ____do____	5,933	19,623	5,008	18,813
Aluminum sulfate ____do____	41,875	1,807	47,688	2,897
Other aluminum compounds ____do____	816,293	109,063	835,920	131,726
Antimony, metals and alloys crude ____do____	871	1,572	340	348
Bauxite, including bauxite concentrates thousand long tons__	16	1,218	19	1,651
Beryllium ____pounds__	143,628	1,107	37,336	1,152
Bismuth, metals and alloys ____do____	329,926	1,520	[1] 128,893	[1] 735
Boron:				
Boric acid ____short tons__	35,740	8,774	33,697	11,532
Sodium borates, refined ____do____	218,107	33,836	212,266	42,486
Cadmium ____thousand pounds__	62	238	396	589
Calcium:				
Carbonate ____short tons__	11,073	1,541	4,640	705
Chloride ____do____	30,866	1,700	28,359	2,314
Dicalcium phosphate ____do____	29,196	6,864	21,053	6,270
Chrome:				
Ore and concentrates:				
Exports ____thousand short tons__	18	1,430	139	6,896
Reexports ____do____	99	3,101	45	2,111
Ferrochrome ____do____	7	3,765	13	9,075
Cobalt ____thousand pounds__	3,679	10,979	4,237	14,881
Columbium metals, alloys, other forms ____do____	33	563	53	787
Copper:				
Ore, concentrate, composition metal and unrefined (copper content) ____short tons__	r 23,381	28,819	16,451	14,454
Scrap ____do____	41,342	46,413	45,002	40,793
Refined copper and semimanufactures ____do____	202,203	448,584	258,165	465,553
Other copper manufactures ____do____	8,332	17,583	9,518	14,158
Copper sulfate or blue vitriol ____do____	1,815	2,138	1,248	2,067
Copper-base alloys ____do____	169,521	284,839	130,254	179,838
Ferroalloys:				
Ferrosilicon ____do____	6,575	3,338	39,712	15,732
Ferrophosphorus ____do____	3,677	408	437	57
Gold:				
Ore and base bullion ____troy ounces__	308,081	49,410	393,970	63,654
Bullion, refined ____do____	3,555,193	179,070	3,101,812	429,278
Iron ore ____thousand long tons__	2,323	35,148	2,537	60,071
Iron and steel:				
Pig iron ____short tons__	100,582	6,743	59,596	4,636
Iron and steel products (major):				
Semimanufactures ____do____	r 4,757,829	1,373,496	1,690,956	633,502
Manufactured steel mill products ____do____	r 2,234,200	r 1,638,541	2,284,043	2,336,341
Iron and steep scrap: Ferrous scrap, including rerolling materials ____thousand short tons__	9,023	881,885	9,642	780,984
Slag ____short tons__	51,902	2,524	139,516	5,506
Lead:				
Pigs, bars, anodes, sheets, etc ____do____	61,982	32,685	21,256	12,041
Scrap ____do____	59,366	16,813	49,951	10,063
Magnesium, metal and alloys, scrap, semimanufactured forms ____do____	46,398	48,511	32,591	48,191
Manganese:				
Ore and concentrate ____do____	223,088	13,656	204,523	13,886
Ferromanganese ____do____	7,011	2,204	32,800	10,601
Metal ____do____	2,318	2,119	3,256	3,318
Mercury:				
Exports ____76-pound flasks__	466	270	339	152
Reexports ____do____	--	--	155	68
Molybdenum:				
Ore and concentrates (molybdenum content) thousand pounds__	78,660	151,075	62,611	159,592
Metals and alloys, crude and scrap ____do____	105	256	317	858
Wire ____do____	415	4,210	270	2,863
Semifabricated forms, n.e.c ____do____	251	1,670	312	1,790
Powder ____do____	203	728	60	296
Ferromolybdenum ____do____	4,094	7,094	2,241	4,798

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products—Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
METALS—Continued				
Nickel:				
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc ----short tons	22,355	$94,980	23,118	$102,400
Catalysts ----do	3,477	9,143	3,536	13,713
Nickel-chrome electric resistance wire ----do	1,117	6,056	679	4,769
Semifabricated forms, n.e.c ----do	3,493	23,319	2,788	20,420
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap ----troy ounces	474,494	78,142	376,450	56,412
Platinum-group metals:				
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap) ----do	361,260	39,279	283,435	31,102
Manufactures, except jewelry ----	NA	3,753	NA	3,246
Rare earths; cerium ore, metal, alloys, lighter flints ----pounds	192,144	503	100,279	300
Silicon:				
Ferrosilicon ----short tons	6,575	3,338	38,452	15,281
Silicon carbide, crude and in grains ----do	r 13,612	5,813	12,970	6,839
Silver:				
Ore, concentrates, waste, sweepings thousand troy ounces	12,699	53,956	10,005	43,481
Bullion, refined ----do	5,691	27,695	22,621	104,086
Tantalum:				
Ore, metal, other forms ----thousand pounds	704	6,813	531	5,545
Powder ----do	233	7,008	161	5,974
Tin:				
Ingots, pigs, bars, etc.:				
Exports ----long tons	5,908	47,774	1,421	10,457
Reexports ----do	2,507	15,700	2,118	15,531
Tin scrap and other tin-bearing material except tinplate scrap ----do	7,325	5,950	5,062	4,343
Titanium:				
Ore and concentrate ----short tons	3,264	727	3,147	505
Sponge (including iodide titanium and scrap) do	4,730	9,288	4,326	7,630
Intermediate mill shapes and mill products, n.e.c ----do	1,719	19,600	1,900	24,726
Dioxide and pigments ----do	[2] 30,379	[2] 24,575	15,807	12,110
Tungsten: Ore and concentrates (tungsten content):				
Exports ----thousand pounds	1,187	4,835	1,316	8,082
Reexports ----do	88	292	316	930
Uranium:				
Ores and concentrates (U_3O_8 content) pounds	--	--	122,663	1,840
Metal ----do	20,496	322	14,840	203
Compounds ----do	4,682,926	30,855	3,837,266	52,040
Isotopes (stable) and their compounds ----	NA	2,786	NA	2,679
Radioactive materials ----thousand curies	25,431,262	16,571	37,850,386	20,088
Special nuclear materials ----	NA	158,267	NA	236,849
Vanadium:				
Ore and concentrate, pentoxide, etc. (vanadium content) ----pounds	406,235	1,327	430,592	1,628
Ferrovanadium ----do	2,670,321	7,863	2,035,851	7,952
Zinc:				
Slabs, pigs, blocks ----short tons	19,062	16,511	6,897	5,870
Sheets, plates, strips, other forms, n.e.c do	3,487	3,842	1,629	2,086
Waste, scrap, and dust (zinc content) ----do	12,088	6,280	5,051	2,448
Semifabricated forms, n.e.c ----do	28,456	27,343	14,196	9,379
Zirconium:				
Ore and concentrate ----pounds	42,973,250	3,323	37,531,345	4,787
Metals, alloys, other forms ----do	1,650,695	18,195	2,649,694	25,829
NONMETALS				
Abrasives:				
Dust and powder of precious or semiprecious stones (including diamond dust and powder) thousand carats	14,005	34,822	12,802	32,088
Crushing bort ----do	11	25	3	12
Industrial diamonds ----do	981	5,460	950	5,948
Diamond grinding wheels ----do	894	5,574	684	4,933
Other natural and artificial metallic abrasives and products ----	NA	69,627	NA	59,868

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products—Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
NONMETALS—Continued				
Asbestos:				
Exports:				
Unmanufactured ....short tons..	55,114	$8,643	34,921	$10,059
Products ....do....	NA	60,256	NA	60,556
Reexports:				
Unmanufactured ....do....	6,609	549	1,526	608
Products ....do....	NA	140	NA	220
Barite:				
Natural barium sulfate ....do....	61,245	2,518	57,386	1,868
Lithopone ....do....	1,185	967	1,833	1,060
Boron, boric acid, borates (crude and refined) do....	r 249,884	42,610	245,963	54,018
Cement ....do....	289,844	14,860	494,132	28,409
Clays:				
Kaolin or china clay ....do....	848,873	42,080	878,619	47,905
Fire clay ....do....	224,110	5,983	219,431	7,191
Other clays ....do....	1,376,888	66,148	1,216,088	65,202
Feldspar, leucite, nepheline and nepheline syenite thousand pounds..	36,638	662	19,087	507
Fluorspar ....short tons..	5,847	316	1,355	194
Gem stones:				
Diamond ....thousand carats..	284	r 304,639	265	236,988
Pearls	NA	817	NA	413
Other	NA	r 19,627	NA	25,480
Graphite ....short tons..	12,189	1,693	10,586	1,890
Gypsum:				
Crude (crushed or calcined) thousand short tons..	132	3,910	75	4,505
Manufactures, n.e.c	NA	6,934	NA	5,976
Lithium hydroxide ....thousand pounds..	1,198	1,118	1,226	1,593
Kyanite and allied minerals ....short tons..	135,982	8,205	150,369	9,355
Lime ....do....	31,639	1,516	53,853	2,746
Magnesium compounds:				
Magnesite and dead burned.thousand pounds..	102,533	7,749	165,309	14,146
Magnesite (crude, caustic calcined, lump or ground) ....do....	21,465	5,088	18,195	4,538
Mica (sheet, waste and scrap and ground) pounds..	16,842,858	3,085	10,977,353	3,154
Mica (manufactured) ....do..	1,053,980	3,430	1,132,301	3,950
Mineral-earth pigments, iron oxide, natural and manufactured ....short tons..	15,585	9,437	13,231	7,710
Nitrogen compounds (major) .thousand short tons..	r 3,757	r 566,533	4,684	841,710
Phosphate rock ....do....	r 14,208	r 255,899	12,606	461,553
Phosphatic fertilizers:				
Superphosphates ....do....	r 1,153	r 227,490	1,180	193,230
Ammonium phosphates ....do....	1,992	358,807	2,422	532,274
Elemental phosphorus ....short tons..	r 33,691	r 20,119	35,845	36,659
Mixed chemical fertilizer thousand short tons..	474	53,476	324	40,695
Pigments and compounds (lead and zinc):				
Lead oxides:				
Pigment grade ....short tons..	3,395	1,926	1,695	901
Other grade ....do....	1,684	1,511	580	490
Zinc oxides:				
Pigment grade ....do....	9,237	4,021	2,389	1,867
Other grade ....do....	3,008	2,417	715	496
Zinc compounds ....do....	1,185	967	917	1,060
Potash:				
Fertilizer ....do....	1,414,598	66,175	1,419,317	[2] 92,701
Chemical ....do....	38,290	14,712	104,497	18,949
Pumice and pumicite ....thousand pounds..	5,821	1,211	2,504	1,027
Quartz (natural), quartzite, cryolite, chiolite short tons..	3,002	808	1,767	1,106
Salt:				
Crude and refined ......thousand short tons..	521	4,276	1,332	9,070
Shipments to noncontiguous territories ..do..	19	1,793	20	2,304
Sand and gravel:				
Sand:				
Construction ....short tons..	658,801	1,132	510,859	1,111
Industrial ....do....	1,123,954	9,864	2,171,109	13,071
Gravel ....do....	472,896	668	537,290	864

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products—Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
NONMETALS—Continued				
Sodium and sodium compounds:				
Sodium sulfate ----short tons--	51	$3,250	77	$6,144
Sodium carbonate ----do----	564	34,156	552	45,985
Stone:				
Dolomite (block) ----do----	86	1,559	49	1,464
Limestone (crushed, ground, broken) --do----	2,793	7,753	3,386	9,993
Marble and other building and monumental --	NA	1,920	NA	2,449
Stone (crushed, ground, broken) thousand short tons--	625	4,850	896	5,843
Manufactures of stone ----	NA	2,077	NA	2,376
Sulfur:				
Crude ----thousand long tons--	2,580	95,516	1,288	69,553
Crushed, ground, flowers of ----do----	21	1,829	7	2,248
Talc (crude and ground) ----short tons--	182,706	6,711	157,681	6,338
FUELS				
Carbon black ----thousand pounds--	201,737	32,947	87,947	15,474
Coal:				
Anthracite ----thousand short tons--	735	16,577	640	25,801
Bituminous ----do----	59,926	2,420,334	65,669	3,232,893
Briquets ----do----	113	6,729	90	9,566
Coke ----do----	1,278	43,564	1,273	74,732
Natural gas ----thousand cubic feet--	r 110,173,729	r 70,209	105,879,552	114,275
Petroleum:				
Crude ----thousand barrels--	1,072	13,565	19	187
Gasoline ----do----	655	12,105	185	3,103
Jet ----do----	655	7,637	326	3,459
Naphtha ----do----	1,293	27,211	1,168	27,271
Kerosine ----do----	33	525	28	437
Distillate oil ----do----	307	5,518	92	1,156
Residual oil ----do----	4,261	41,232	4,892	43,179
Lubricating oil ----do----	r 11,307	321,951	8,827	300,873
Asphalt ----do----	341	5,238	245	6,222
Liquefied petroleum gases ----do----	9,033	94,464	9,432	100,041
Wax ----do----	862	34,464	581	27,502
Coke ----do----	40,790	181,171	36,949	315,239
Petrochemical feedstocks ----do----	5,558	65,712	7,436	95,681
Miscellaneous ----do----	1,194	44,433	1,088	43,976
Total ----	XX	r 12,645,291	XX	14,381,190

r Revised. NA Not available. XX Not applicable.
[1] Data shown pending clarification by source, subject to change, Bureau of the Census.
[2] Adjusted by the Bureau of Mines.

Table 10.—U.S. imports for consumption of principal minerals and products

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
METALS				
Aluminum:				
Metal ---short tons--	508,643	$312,479	434,119	$316,873
Scrap ---do---	74,743	42,569	54,806	27,586
Plates, sheets, bars, etc ---do---	46,081	47,489	61,354	65,079
Aluminum oxide (alumina) ---do---	3,627,024	270,617	3,507,415	370,039
Antimony:				
Ore (antimony content) ---do---	14,655	20,866	8,320	14,535
Needle or liquated ---do---	86	271	74	255
Metal ---do---	2,203	7,550	2,112	5,677
Oxide ---do---	6,269	15,580	9,908	12,588
Arsenic:				
White (As_2O_3 content) ---do---	13,742	2,449	12,013	4,426
Metallic ---do---	707	3,651	483	2,716
Bauxite (crude) ---thousand long tons--	14,308	NA	10,782	NA
Beryllium ore ---short tons--	1,368	414	[1] 1,479	[1] 468
Bismuth ---pounds--	1,893,744	15,606	1,331,173	9,442
Boron:				
Carbide ---do---	75,429	265	137,572	645,354
Boric acid ---do---	844,811	149	345,237	59,339
Calcium borate (crude) ---do---	42,427,527	852	55,282,329	1,559,662
Cadmium:				
Metal ---short tons--	1,985	14,674	2,618	13,902
Flue dust (cadmium content) ---do---	166	603	346	1,489
Calcium:				
Metal ---pounds--	109,252	121	70,128	78
Chloride ---short tons--	3,599	156	12,021	598
Chromate:				
Ore and concentrates (Cr_2O_3 content) thousand short tons--	481	28,532	559	60,651
Ferrochrome ---do---	r 103	r 55,924	198	190,630
Metal ---do---	2	5,388	2	6,630
Cobalt:				
Metal ---thousand pounds--	14,791	49,661	6,092	25,611
Oxide (gross weight) ---do---	1,509	4,514	233	779
Salts and compounds (gross weight) --do---	2	12	41	74
Columbium ore ---do---	3,129	3,207	1,542	2,012
Copper (copper content):				
Ore and concentrates ---short tons--	r 84,728	r 121,422	29,301	35,649
Regulus, black, coarse ---do---	2,426	12,033	5,675	20,560
Unrefined, black, blister ---do---	200,607	383,491	78,969	90,846
Refined in ingots, etc ---do---	313,349	551,442	142,945	166,159
Old and scrap ---do---	31,109	r 50,641	14,399	14,459
Ferroalloys, n.e.c ---do---	r 81,709	r 38,102	62,125	36,991
Gallium ---kilograms--	6,536	4,107	6,830	3,555
Gold:				
Ore and base bullion ---troy ounces--	329,357	45,974	313,038	50,055
Bullion ---do---	2,321,981	350,706	2,348,936	406,583
Indium ---do---	492,978	1,906	113,800	629
Iron ore ---thousand long tons--	48,029	696,298	46,743	860,496
Iron and steel:				
Pig iron ---short tons--	342,348	41,038	478,106	69,316
Iron and steel products (major):				
Iron products ---do---	49,524	29,328	47,535	32,299
Steel products ---do---	r 16,696,509	r 5,553,378	12,440,326	4,475,191
Scrap ---do---	188,480	26,166	293,082	24,464
Tinplate ---do---	12,645	861	12,277	786
Lead:				
Ore, flue dust, matte (lead content) --do---	62,691	15,180	45,024	12,329
Base bullion (lead content) ---do---	831	331	462	183
Pigs and bars (lead content) ---do---	118,367	57,693	99,054	46,703
Reclaimed scrap, etc. (lead content) ---do---	1,236	834	1,741	617
Sheet, pipe, shot ---do---	196	138	147	99
Magnesium:				
Metallic and scrap ---do---	4,815	3,518	6,787	9,299
Alloys (magnesium content) ---do---	440	1,573	1,111	2,215
Sheets, tubing, ribbons, wire, and other forms (magnesium content) ---do---	50	135	5	33
Manganese:				
Ore (35% or more manganese) (manganese content) ---do---	592,818	45,091	765,530	77,103
Ferromanganese (manganese content) ---do---	327,874	88,426	306,650	128,381
Metal ---do---	2,506	1,379	4,378	4,041

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
METALS—Continued				
Mercury:				
Compounds ---pounds--	62,807	$153	5,122	$40
Metal ---76-pound flasks--	52,180	13,948	43,865	7,599
Minor metals, selenium and salts ---pounds--	841,259	10,611	889,320	10,265
Molybdenum:				
Ore (content) ---do----	155,125	217	2,566,680	5,916
Waste and scrap ---do----	100,159	218	44,672	101
Metal ---do----	53,947	574	38,926	434
Compounds ---do----	r 1,456,133	1,515	682,039	745
Nickel:				
Pigs, ingots, shot, cathodes ---short tons--	137,314	450,342	107,084	406,894
Plates, bars, etc ---do----	r 1,384	r 7,499	1,747	11,118
Slurry ---do----	42,999	96,959	23,991	63,522
Scrap ---do----	3,699	8,545	2,353	5,864
Powder and flakes ---do----	9,371	33,545	9,772	39,413
Ferronickel ---do----	102,430	87,255	65,046	67,818
Oxide ---do----	6,449	15,081	5,063	15,172
Platinum-group metals:				
Unwrought:				
Grains and nuggets (platinum) ---troy ounces--	71,154	13,626	19,253	2,941
Sponge (platinum) ---do----	r 839,526	r 151,705	567,466	91,567
Sweepings, waste and scrap ---do----	r 132,362	r 18,699	116,523	14,278
Iridium ---do----	28,980	9,432	14,419	6,892
Palladium ---do----	588,014	74,433	409,862	33,863
Rhodium ---do----	97,058	39,957	80,197	34,400
Ruthenium ---do----	63,884	3,678	16,535	926
Other platinum-group metals ---do----	r 274,026	r 50,800	234,757	37,055
Semimanufactured:				
Platinum ---do----	199,355	35,388	96,630	15,337
Palladium ---do----	750,073	75,553	144,240	15,163
Rhodium ---do----	1,549	898	1,832	675
Other platinum-group metals ---do----	r 205,330	r 30,450	118,570	19,726
Radium: Radioactive substitutes ---	NA	7,565	NA	8,297
Rare earths, ferrocerium and other cerium alloys ---pounds--	57,519	238	33,852	187
Silicon (silicon content):				
Metal ---short tons--	5,914	16,700	3,852	6,591
Ferrosilicon ---do----	r 93,131	r 66,501	47,365	41,950
Silver (general imports):				
Ore and base bullion --thousand troy ounces--	34,568	150,284	21,197	87,755
Bullion ---do----	89,963	432,868	61,629	274,254
Sweepings, waste, dore ---do----	8,864	40,642	7,596	32,527
Tantalum ore ---thousand pounds--	1,897	7,169	1,624	7,149
Tin:				
Ore (tin content) ---long tons--	5,877	35,999	6,314	44,114
Blocks, pigs, grains, etc ---do----	39,602	289,592	43,665	312,346
Dross, skimmings, scrap, residues and tin alloys, n.s.p.f ---do----	1,761	1,186	2,429	2,452
Tinfoil, powder, flitters, etc ---	NA	9,331	NA	7,257
Titanium:				
Ilmenite [2] ---short tons--	318,720	13,715	334,692	15,903
Rutile ---do----	r 246,489	r 38,773	224,499	46,362
Metal ---pounds--	20,090,390	19,546	10,549,619	18,332
Ferrotitanium ---do----	4,592,316	3,122	1,071,048	1,125
Compounds and mixtures ---do----	r 70,868,757	25,216	53,964,945	19,654
Tungsten (tungsten content):				
Ore and concentrates ---thousand pounds--	11,096	40,698	6,570	31,665
Waste and scrap ---do----	179	711	71	317
Other alloys ---do----	2,462	9,368	1,898	11,104
Ferrotungsten ---do----	808	3,029	418	2,542
Uranium and other uranium-bearing and nuclear materials:				
Oxide U_3O_8 ---do----	3,670,678	30,284	2,451,538	24,481
Compounds, n.e.c ---do----	12,866,822	90,921	19,226,578	161,507
Isotopes (stable) and their compounds ---	NA	1,007	NA	957
Radio isotopes, elements, etc--thousand curies--	24,246,498	7,565	35,346,036	8,297
Vanadium (content):				
Ferrovanadium ---thousand pounds--	288	1,142	273	1,435
Vanadium-bearing materials (vanadium pentoxide content) ---do----	7,744	5,566	8,185	7,075

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
METALS—Continued				
Zinc:				
Ore (zinc content) ---short tons--	133,733	$31,430	428,544	$108,822
Blocks, pigs, slabs ---do---	543,806	[r] 431,251	374,922	273,636
Sheets, etc ---do---	640	568	236	507
Old, dross, skimmings ---do---	3,863	1,786	3,158	1,238
Dust, powder, flakes ---do---	9,131	9,799	5,739	5,744
Manufactures ---	NA	563	NA	79
Zirconium:				
Ore (including zirconium sand) ---do---	62,504	6,398	40,205	8,874
Unwrought, scrap, compounds ---do---	2,702	4,365	2,013	5,991
NONMETALS				
Abrasives:				
Diamond (industrial) ---thousand carats--	[r] 18,417	62,920	14,291	53,383
Other abrasives ---	NA	80,054	NA	68,481
Asbestos ---short tons--	766,164	123,822	538,553	111,011
Barite:				
Crude and ground ---do---	764,625	9,155	672,528	9,264
Witherite ---do---	3,435	710	85	44
Chemicals ---do---	43,383	13,033	10,937	4,443
Cement ---thousand short tons--	5,732	101,734	3,702	70,620
Clays:				
Raw ---short tons--	37,012	1,778	33,851	1,644
Manufactured ---do---	5,806	415	4,143	303
Cryolite ---do---	21,216	6,969	22,120	9,058
Feldspar:				
Crude ---do---	30	([3])	[1] 209	17
Ground and crushed ---do---	62	3	81	6
Fluorspar ---do---	1,336,389	60,988	1,050,448	61,059
Gem stones:				
Diamond ---thousand carats--	4,533	760,040	4,577	722,119
Emeralds ---do---	871	34,046	806	40,348
Other ---	NA	88,234	NA	87,965
Graphite ---short tons--	82,636	5,677	65,663	5,698
Gypsum:				
Crude, ground, calcined-thousand short tons--	7,426	17,709	5,450	16,193
Manufactures ---	NA	4,180	NA	3,617
Iodine (crude) ---thousand pounds--	7,970	14,849	5,309	11,721
Kyanite ---short tons--	194	12	65	3
Lime:				
Hydrated ---do---	48,284	1,311	44,637	1,392
Other ---do---	367,917	6,368	214,311	4,867
Lithium:				
Ore ---do---	3,165	323	4,548	538
Compounds ---do---	84	249	11	107
Magnesium compounds:				
Crude magnesite ---do---	19	1	10	1
Lump, ground, caustic calcined magnesia ---do---	8,990	692	5,716	502
Refractory magnesia, dead-burned fused magnesite, dead-burned dolomite ---do---	156,401	18,455	156,332	24,668
Compounds ---do---	32,064	2,107	36,572	1,796
Mica:				
Uncut sheet and punch ---thousand pounds--	[r] 793	947	904	696
Scrap ---do---	6,634	193	10,672	356
Manufactures ---do---	[r] 6,554	4,928	5,075	2,935
Mineral-earth pigments; iron oxide pigments:				
Ocher (crude and refined) ---short tons--	53	10	20	3
Siennas (crude and refined) ---do---	1,309	264	521	107
Umber (crude and refined) ---do---	7,790	565	4,251	350
Vandyke brown ---do---	958	183	319	57
Natural, other ---do---	2,162	376	1,001	223
Synthetic ---do---	41,943	14,969	21,867	8,444
Nepheline syenite:				
Crude ---do---	4,605	79	6,275	98
Ground, crushed, etc ---do---	505,028	7,558	424,838	6,869
Nitrogen compounds (major), including urea ---thousand short tons	3,374	345,230	3,113	415,534
Phosphate (crude) ---do---	[1] 182	[1] 8,999	37	1,604
Phosphatic fertilizers ---do---	202	32,512	147	26,970
Pigments and salts:				
Lead pigments and compounds ---short tons--	14,384	10,001	15,337	7,470
Zinc pigments and compounds ---do---	39,436	26,048	18,447	10,746
Potash ---do---	7,265,222	256,082	6,292,329	285,272

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1974		1975	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS—Continued				
Pumice:				
Crude or unmanufactured ------- short tons--	8,415	$228	3,260	$77
Wholly or partly manufactured ------- do----	284,505	1,214	142,120	380
Manufactures, n.s.p.f ----------------------	NA	80	NA	76
Quartz crystal (Brazilian pebble) ------ pounds--	1,731,913	624	1,487,272	931
Salt --------------------- thousand short tons--	3,358	14,428	3,215	15,272
Sand and gravel:				
Glass sand -------------------------- do----	51	486	45	475
Other sand and gravel --------------- do----	343	352	329	301
Sodium sulfate ------------------------- do----	375	10,382	285	12,624
Stone and whiting ----------------------------	NA	51,631	NA	45,625
Strontium:				
Mineral ---------------------- short tons--	38,431	1,145	21,613	826
Compounds ----------------------- do----	8,547	3,095	3,100	1,261
Sulfur and compounds, sulfur ore and other forms n.e.s -------------- thousand long tons--	2,150	51,124	1,897	70,848
Talc, unmanufactured -------------- short tons--	30,252	2,233	23,378	1,471
MINERAL FUELS				
Carbon black:				
Acetylene ----------------------- pounds--	7,749,624	2,814	5,839,266	2,578
Gas black and carbon black ------------- do--	29,615,297	4,329	33,034,187	4,284,281
Coal:				
Bituminous (slack and culm) and lignite ---------------------- short tons--	2,080,407	57,731	939,721	21,682
Briquets --------------------------- do----	48,233	888	16,367	270
Coke ------------------------------ do----	3,540,326	193,165	1,818,981	156,488
Natural gas, ethane, methane, and mixtures thereof ---------------- thousand cubic feet--	967,116,135	503,277	944,352,390	1,070,539
Peat:				
Fertilizer grade --------------- short tons--	323,263	22,316	283,732	23,371
Poultry and stable grade ------------- do----	3,267	266	6,626	488
Petroleum:				
Crude petroleum ---------- thousand barrels--	1,362,453	15,252,724	1,581,129	18,290,012
Distillate --------------------------- do----	83,033	995,549	39,420	489,351
Residual ---------------------------- do----	499,914	5,037,761	362,084	3,958,178
Unfinished oils ---------------------- do----	13,866	172,189	1,514	18,042
Gasoline ---------------------------- do----	33,903	570,829	22,740	314,971
Jet fuel ---------------------------- do----	56,667	649,685	44,368	619,102
Motor fuels, n.e.s ------------------- do----	955	10,907	666	8,799
Kerosine ---------------------------- do----	1,023	20,354	46	511
Lubricants -------------------------- do----	r 310	6,983	130	4,159
Wax -------------------------------- do----	352	11,257	157	6,128
Naphtha ---------------------------- do----	88,275	1,131,872	64,654	782,485
Liquefied petroleum gases ------------ do----	45,091	365,028	41,171	354,947
Asphalt ---------------------------- do----	12,209	64,144	4,835	52,274
Miscellaneous ---------------------- do----	19,353	159,768	21,285	248,453
Total ----------------------------------	XX	r 39,586,403	XX	45,389,660

r Revised. NA Not available. XX Not applicable.
[1] Adjusted by the Bureau of Mines.
[2] Includes titanium slag averaging about 70% TiO_2, for details, see Titanium chapter.
[3] Less than ½ unit.

Table 11.—Comparison of world and U.S. production of principal mineral commodities

(Thousand short tons unless otherwise specified)

Minerals	1974 World production [1]	1974 U.S. production	1974 U.S. percent of world production	1975 [p] World production [1]	1975 [p] U.S. production	1975 [p] U.S. percent of world production
MINERAL FUELS						
Carbon black ---million pounds--	7,803	3,390	43	6,854	2,741	40
Coal:						
Bituminous	[2] 1,866,952	585,504	31	[2] 1,976,204	628,619	32
Lignite	919,495	15,496	2	948,265	19,819	2
Pennsylvania anthracite	193,686	6,617	3	195,195	6,203	3
Coke (excluding breeze):						
Gashouse [3]	20,009	--	--	19,285	--	--
Oven and beehive	404,898	61,581	15	398,152	57,207	14
Natural gas (marketable) million cubic feet--	47,171,491	21,600,522	46	47,207,325	20,108,661	43
Peat	220,695	731	(4)	223,327	772	(4)
Petroleum (crude) thousand barrels--	20,537,727	3,202,585	16	19,497,213	3,056,779	16
NONMETALS						
Asbestos	4,589	113	2	4,509	99	2
Barite	4,944	1,106	22	5,296	1,287	24
Cement	776,066	[5] 82,888	11	766,347	[5] 69,722	9
Clay, china	17,880	[6] 6,393	36	16,338	[6] 5,334	33
Corundum	9	--	--	9	--	--
Diamond ------thousand carats--	44,522	--	--	41,126	--	--
Diatomite	1,865	664	36	1,791	573	32
Feldspar	3,310	763	23	3,041	670	22
Fluorspar	5,347	201	4	5,114	140	3
Graphite	541	W	NA	485	W	NA
Gypsum	64,622	11,999	19	60,305	9,751	16
Lime (sold or used)	123,183	[5] 21,645	18	115,149	[5] 19,161	17
Magnesite	11,090	W	NA	10,995	W	NA
Mica (including scrap) thousand pounds--	515,410	273,952	53	515,616	269,775	52
Nitrogen, agricultural [7]	44,613	[5] 10,095	23	46,505	[5] 9,503	20
Phosphate rock	122,147	45,686	37	118,586	48,816	41
Potash (K_2O equivalent)	26,432	2,552	10	27,423	2,501	9
Pumice [8]	15,377	3,937	26	14,900	3,892	26
Pyrites ------thousand long tons--	22,271	424	2	22,119	625	3
Salt	182,102	[5] 46,565	26	179,107	[5] 41,057	23
Strontium [8]	109	--	--	59	--	--
Sulfur, elemental thousand long tons--	49,362	11,419	23	49,164	11,259	23
Talc, pyrophyllite, soapstone	6,284	1,290	21	5,345	928	17
Vermiculite [8]	555	341	61	577	330	57
METALS, MINE BASIS						
Antimony (content of ore and concentrate) ------short tons--	79,232	661	1	74,802	886	1
Arsenic, white ------------do----	56,027	W	NA	51,289	W	NA
Bauxite -----thousand long tons--	76,810	[9] 1,949	3	73,939	[9] 1,772	2
Beryl ---------------short tons--	3,472	--	NA	3,558	W	NA
Bismuth ------thousand pounds--	10,639	W	NA	7,888	W	NA
Chromite	8,187	--	--	8,741	--	--
Cobalt (contained) --short tons--	35,791	--	--	36,282	--	--
Columbium-tantalum concentrate [8] thousand pounds--	52,727	--	--	51,502	--	--
Copper (content of ore and concentrate)	8,063	[10] 1,597	20	7,679	[10] 1,413	18
Gold ------thousand troy ounces--	39,941	1,127	3	38,574	1,052	3
Iron ore ----thousand long tons--	881,244	[11] 84,355	9	880,364	[11] 78,866	9
Lead (content of ore and concentrate)	3,832	664	17	3,788	621	16
Manganese ore (35% or more Mn)	25,068	--	--	26,896	--	--
Mercury thousand 76-pound flasks--	261	2	1	251	7	3
Molybdenum (content of ore and concentrate) -thousand pounds--	189,274	112,011	59	178,883	105,980	59
Nickel (content of ore and concentrate)	871	17	2	900	17	2

See footnotes at end of table.

Table 11.—Comparison of world and U.S. production of principal mineral commodities—Continued

(Thousand short tons unless otherwise specified)

Minerals	1974 World production[1]	1974 U.S. production	1974 U.S. percent of world production	1975 p World production[1]	1975 p U.S. production	1975 p U.S. percent of world production
METALS, MINE BASIS—Continued						
Platinum-group metals thousand troy ounces	5,774	13	(4)	5,767	19	(4)
Silver do	294,935	33,762	11	294,268	34,938	12
Tin (concentrate of ore and concentrate) metric tons	233,747	W	NA	225,195	W	NA
Titanium concentrates:						
Ilmenite[8]	3,099	745	24	2,854	717	25
Rutile[8]	365	6	2	387	W	NA
Tungsten concentrate (contained tungsten) thousand pounds	81,509	7,381	9	82,580	5,588	7
Uranium oxide (U_3O_8)[8] short tons	24,576	11,614	47	26,442	11,439	43
Vanadium (content of ore and concentrate) do	21,112	4,870	23	23,831	4,743	20
Zinc (content of ore and concentrate)	6,281	500	8	6,131	469	8
METALS, SMELTER BASIS						
Aluminum	14,528	4,903	34	13,273	3,879	29
Cadmium short tons	19,038	[12] 3,333	18	16,906	[12] 2,193	13
Copper	8,111	[13] 1,570	19	7,780	[13] 1,447	19
Iron, pig	564,501	95,477	17	526,017	79,721	15
Lead	3,858	[14] 673	17	3,714	[14] 636	17
Magnesium	145	W	NA	142	W	NA
Selenium[8] thousand pounds	2,709	644	24	2,508	358	14
Steel ingots and castings	780,007	[15] 145,720	19	712,588	[15] 116,642	16
Tellurium[8] thousand pounds	447	191	43	328	131	40
Tin metric tons	228,341	[16] 6,096	3	230,055	[16] 6,500	3
Zinc	6,022	555	9	5,557	496	9

p Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data.

[1] May not represent total world production because confidential U.S. data are excluded for some commodities. World totals include reported figures and reasonable estimates; however, for some commodities where data were not available, no reasonable estimates could be made and none have been included.

[2] Includes small quantities of lignite for the People's Republic of China and Pakistan, and anthracite for Colombia.

[3] Includes low- and medium-temperature and gashouse coke.

[4] Less than ½ unit.

[5] Includes Puerto Rico.

[6] Kaolin sold or used by producers.

[7] Year ended June 30 of year stated (United Nations).

[8] World total exclusive of the U.S.S.R.

[9] Dry bauxite equivalent of crude ore.

[10] Recoverable.

[11] Includes byproduct ore.

[12] Includes secondary.

[13] Smelter output from domestic and foreign ores, exclusive of scrap.

[14] Lead refined from domestic and foreign ores; excludes lead refined from imported base bullion.

[15] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingot.

[16] Includes tin content of alloys made directly from ore.

Abrasive Materials

By Robert G. Clarke [1]

The production of natural abrasives varied in quantity and value compared with those of 1974. Output of tripoli-type materials and garnet both decreased in quantity and value. Special silica stone products decreased in quantity but increased in value. The production of emery increased 38% in quantity. The production of manufactured abrasive materials decreased for all types and the decreases were more in quantity than in value.

Table 1.—Salient abrasive statistics in the United States

Kind	1971	1972	1973	1974	1975
Natural abrasives (domestic) sold or used by producers:					
Tripoli (crude) ---------- short tons --	75,134	87,864	101,519	r 85,121	80,562
Value ---------- thousands --	$569	$797	$929	r $623	$565
Special silica stone products [1] short tons --	2,349	3,241	3,466	3,134	2,953
Value ---------- thousands --	$563	$670	$677	$717	$1,061
Garnet ---------- short tons --	18,984	18,916	22,772	24,684	17,204
Value ---------- thousands --	$1,934	$1,957	$2,380	$2,551	$1,690
Emery ---------- short tons --	1,586	2,883	2,884	2,520	3,487
Value ---------- thousands --	W	W	W	W	W
Artificial abrasives [2] ---------- short tons --	472,299	584,680	[3] 645,813	[3] r 730,405	[3] 528,307
Value ---------- thousands --	$79,027	$92,958	[3] $108,808	[3] $175,678	[3] $141,580
Foreign trade (natural and artificial abrasives):					
Exports (value) ---------- do ----	$60,685	$64,219	$82,969	$115,508	$102,849
Reexports (value) ---------- do ----	$21,711	$26,746	$29,413	r $29,829	$28,862
Imports for consumption (value) do ----	$89,085	$106,512	$136,655	$142,974	$121,864

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes grinding pebbles, grindstones, oilstones, tube-mill liners, and whetstones.
[2] Production of silicon carbide and aluminum oxide (United States and Canada); shipments of metallic abrasives (United States).
[3] Includes production of aluminum zirconium oxide (United States and Canada).

FOREIGN TRADE

Imports of abrasive materials were 15% less in value than in 1974, and exports plus reexports decreased in value 10%. Net exports, the excess of exports and reexports over imports, were $9.3 million, about four times that of 1974. The volume of all abrasive materials exported decreased and the value of nearly all decreased.

Industrial diamond imports totaled 14.3 million carats of loose material valued at $53.4 million, a decrease of 22% in quantity and 15% in value from those of 1974. Exports of industrial diamond, loose, were 13.8 million carats, a decrease of 8%, and the value was $38.0 million, a decrease of 6%. Reexports of similar industrial diamond were 3.2 million carats, a decrease of 12%, and the value was $28.2 million, a decrease of 5%. The diamond content in diamond wheels, exported and reexported, was 692,000 carats, a decrease of 23%, and the declared value was $5.0 million, a decrease of 11%. Imports of diamond wheels are listed by number and value; the value in 1975 decreased to $896,000 from $971,000 in 1974.

[1] Physical scientist, Division of Nonmetallic Minerals.

The 1975 imports of industrial diamond from Ireland totaled 4.5 million carats valued at $10.4 million, reflecting a decrease of 46% in quantity and 44% in value from those of 1974. The share of imports from Ireland was 31% of the total quantity and 20% of value. Of the industrial imported bort, powder, and dust, synthetic diamond was 3.2 million carats valued at $6.6 million and natural diamond was 5.9 million carats valued at $12.4 million.

Table 2.—U.S. exports of abrasive materials, by kind
(Thousands)

Kind	1974		1975	
	Quantity	Value	Quantity	Value
NATURAL ABRASIVES				
Dust and powder of natural and synthetic precious or semiprecious stones, including diamond dust and powder carats	14,005	$34,822	12,802	$32,088
Crushing bort, except dust and powder do	11	25	3	12
Industrial diamond do	981	5,460	950	5,948
Emery, natural corundum, and other natural abrasives, n.e.c pounds	39,784	5,746	21,366	4,138
MANUFACTURED ABRASIVES				
Artificial corundum (fused aluminum oxide) do	64,632	14,898	[1]53,302	[1]13,638
Silicon carbide, crude or in grains do	27,224	5,813	25,939	6,839
Carbide abrasives, n.e.c do	1,748	4,905	1,324	4,533
Grinding and polishing wheels and stones:				
Diamond carats	894	5,574	684	4,933
Pulpstones pounds	3,315	1,130	2,991	1,476
Polishing stones, whetstones, oilstones, hones, and similar stones do	1,261	1,624	912	1,315
Wheels and stones, n.e.c do	5,551	12,523	5,156	11,970
Abrasive paper and cloth, coated with natural or artificial abrasive materials reams	528	19,844	282	11,998
Coated abrasives, n.e.c	NA	3,144	NA	3,961
Total	XX	115,508	XX	102,849

NA Not available. XX Not applicable.
[1] Adjusted by the Bureau of Mines.

Table 3.—U.S. reexports of abrasive materials, by kind
(Thousands)

Kind	1974		1975	
	Quantity	Value	Quantity	Value
NATURAL ABRASIVES				
Dust and powder of natural and synthetic precious or semiprecious stones, including diamond dust and powder carats	369	$1,010	435	$958
Crushing bort except dust and powder do	465	3,302	371	1,958
Industrial diamond do	2,856	25,274	2,425	25,294
Emery, natural corundum, and other natural abrasives, n.e.c. pounds	4	100	5	3
MANUFACTURED ABRASIVES				
Artificial corundum (fused aluminum oxide) do	r 475	r 26	63	5
Silicon carbide, crude or in grains do	r 45	r 10	--	--
Grinding and polishing wheels and stones:				
Diamond carats	([1])	3	--	--
Wheels and stones, n.e.c pounds	7	40	8	49
Abrasive paper and cloth, coated with natural or artificial abrasive materials reams	18	14	9	28
	([1])	1	1	38
Coated abrasives, n.e.c	NA	49	NA	29
Total	XX	r 29,829	XX	28,362

r Revised. NA Not available. XX Not applicable.
[1] Less than ½ unit.

Table 4.—U.S. imports for consumption of abrasive materials (natural and artificial), by kind
(Thousands)

Kind	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Corundum, crude ---- short tons	2	$158	1	$81
Emery, flint, rottenstone, and tripoli, crude or crushed ---- do	17	843	6	426
Silicon carbide, crude ---- do	98	15,720	85	16,544
Aluminum oxide, crude ---- do	204	33,599	128	24,273
Other crude artificial abrasives ---- do	4	676	2	411
Abrasives, ground grains, pulverized or refined:				
Rottenstone and tripoli ---- do	(1)	1	(1)	1
Silicon carbide ---- do	3	2,080	1	1,133
Aluminum oxide ---- do	9	3,197	3	1,635
Emery, corundum, flint, garnet, and other, including artificial abrasives ---- do	1	256	(1)	115
Papers, cloths, and other materials wholly or partly coated with natural or artificial abrasives ----	(2)	17,496	(2)	17,140
Hones, whetstones, oilstones, and polishing stones number	243	106	210	188
Abrasive wheels and millstones:				
Burrstones manufactured or bound up into millstones short tons	(1)	2	(1)	1
Solid natural stone wheels ---- number	1	15	3	19
Diamond ---- do	64	971	35	896
Abrasive wheels bonded with resins ---- do	828	1,924	1	2,376
Other ----	(2)	1,590	(2)	2,083
Articles not especially provided for:				
Emery or garnet ----	(2)	15	(2)	21
Natural corundum or artificial abrasive materials ----	(2)	412	(2)	440
Other ----	(2)	296	(2)	290
Diamond:				
Diamond dies ---- number	19	697	12	458
Crushing bort ---- carats	r 143	365	283	668
Other industrial diamond ---- do	r 5,079	r 31,209	4,096	27,636
Miners' diamond ---- do	r 1,324	6,883	1,166	6,773
Dust and powder ---- do	r 11,871	r 24,463	8,746	18,306
Total ----	XX	r 142,974	XX	121,864

r Revised. XX Not applicable.
1 Less than ½ unit.
2 Quantity not reported.

TRIPOLI

Fine-grained, porous, silica materials are grouped together because they have similar properties and end uses. Production of crude tripoli (table 1) decreased 5% in quantity and 9% in value compared with 1974. Processed tripoli sold or used (table 5) decreased 21% in quantity and 24% in value. The uses for processed tripoli in 1975 were 57% for abrasives and 41% for fillers compared with 59% and 39%, respectively, in 1974.

Tripoli producers in 1975 were Malvern Minerals Co., Garland County, Ark., which produced crude and finished material; Midwestern Minerals Corp., Ottawa County, Okla., which produced crude and finished material; and American Tripoli Co., Division of The Carborundum Co., which produced crude in Ottawa County, Okla., and finished material in Newton County, Mo. Illinois Minerals Co., and Tammsco, Inc., both in Alexander County, Ill., produced amorphous silica. Keystone Filler and Mfg. Co., in Northumberland County, Pa., mined and processed rottenstone.

Prices quoted in Engineering and Mining Journal, December 1975, for tripoli and amorphous silica were as follows:

Tripoli, paper bags, carload lots, f.o.b., in cents per pound:	
White, Elco, Ill.: Air floated through 200 mesh ----	1.4
Rose and cream, Seneca, Mo. and Rogers, Ark.:	
Once ground ----	2.90
Double ground ----	2.90
Air float ----	3.15
Amorphous silica, bags, f.o.b., in dollars per ton:	
Elco, Ill.:	
Through 200 mesh, 90% to 95% ----	$28
Through 200 mesh, 96% to 99% ----	29
Through 325 mesh, 96% to 98% ----	32.50
Through 325 mesh, 98% to 99.4% ----	34
Through 325 mesh, 99.5% ----	48.50
Through 400 mesh, 99.9% ----	71
Below 15 micrometers, 99% ----	78.50
Below 10 micrometers, 99% ----	100
Dierks, Ark.:	
200 mesh ----	40
325 mesh ----	50

Table 5.—Processed tripoli[1] sold or used by producers in the United States, by use[2]

Use		1971	1972	1973	1974	1975
Abrasives	short tons	44,899	47,321	55,420	50,615	38,815
Value	thousands	$1,692	$1,918	$2,233	$2,251	$1,518
Filler	short tons	20,457	25,973	32,407	33,361	27,630
Value	thousands	$681	$847	$1,158	$1,346	$1,205
Other	short tons	1,327	1,584	2,105	2,025	1,739
Value	thousands	$32	$43	$62	$66	$60
Total[3]	short tons	66,683	74.878	89,932	86,000	68,184
Value[3]	thousands	$2,406	$2,807	$3,453	$3,665	$2,783

[1] Includes amorphous silica and Pennsylvania rottenstone.
[2] Partly estimated.
[3] Data may not add to totals shown because of independent rounding.

SPECIAL SILICA STONE PRODUCTS

Special silica stone products produced in 1975 included oilstones from Arkansas, whetstones from Arkansas and Indiana, grindstones from Ohio, grinding pebbles and deburring media from Minnesota and Wisconsin, and tube-mill liners from Minnesota.

Producers of oilstones and whetstones in Garland County, Ark., were John O. Glassford, Hiram A. Smith, Inc., Arkansas Abrasives, Inc., and Norton Pike Division of Norton Co. Whetstones were produced by Milroy and Smith in Hot Springs County, Ark., and by K & K Mines, Inc., in Pike County, Ark. Hindostan Whetstone Co. operated a plant in Lawrence County, Ind., to finish stone obtained from a quarry in Orange County, Ind. Cleveland Quarries Co. produced grindstones at its Amherst quarry, Lorrain County, Ohio. Jasper Stones Co. produced grinding media, rough and rounded, from its quarry in Rock County, Minn., and Baraboo Quartzite Co., Inc., produced deburring media at its quarry in Sauk County, Wis.

Table 6.—Special silica stone products sold or used in the United States[1]

Year	Quantity (short tons)	Value sands) (thou-
1971	2,349	$563
1972	3,241	670
1973	3,466	677
1974	3,134	717
1975	2,953	1,061

[1] Includes grinding pebbles, grindstones, oilstones, tube-mill liners, and whetstones.

NATURAL SILICATE ABRASIVES

Garnet.—Sales of domestic garnet decreased 30% in quantity and 34% in value from the highs of 1974. Three producers were active in 1975—two in Idaho and one in New York. Barton Mines Corp., Warren County, N.Y, sold garnet for use in coated abrasives, glass grinding and polishing, and metal lapping. Emerald Creek Garnet Milling Co., and Idaho Garnet Abrasive Co., both in Benewah County, Idaho, reported their garnet was used in sandblasting, water filtration, as a filler in rubber products, and as an additive in decorations.

Prices for Idaho garnet, f.o.b. Fernwood, Idaho, ranged from 4.0 to 7.0 cents per pound. Prices for New York garnet, f.o.b. North Creek, N.Y., ranged from 15 to 35 cents per pound.

Table 7.—Abrasive garnet sold or used by producers in the United States

Year	Quantity (short tons)	Value (thousands)
1971	18,984	$1,934
1972	18,916	1,957
1973	22,772	2,380
1974	24,684	2,551
1975	17,204	1,690

NATURAL ALUMINA ABRASIVES

Corundum.—No domestic corundum was produced in 1975. Requirements for domestic consumption were met by imports mainly from the Republic of South Africa. A small quantity of corundum was imported from India. Total imports were 1,124 tons at a declared value of $80,888.

Prices quoted in Engineering and Mining Journal, December 1975, for crystal corundum, per short ton of crude, c.i.f. U. S. ports, were $150 to $160.

Emery.—Three producers of emery were active in 1975: De Luca Emery Mine, Inc., and Emeri Crete, Inc., both near Peekskill in Westchester County, N.Y., and Oregon Emery Co., near Sweethome in Linn County, Oreg. Domestic emery was used mostly in aggregates as a nonslip additive for floors, pavements, and stair treads. The minor use for domestic emery was in abrasive materials for coated abrasives and tumbling or deburring media. The quantity of emery produced was 3,487 tons.

World production data for emery are principally for Greece and Turkey. In 1974, production of emery in Greece was estimated to be 7,716 tons. Production of emery in Turkey in 1974 was reported as 166,210 tons. No value was placed on the production in either country.

Prices quoted in Industrial Minerals, No. 99, December 1975, for emery, per metric ton, c.i.f. main European port, were as follows, in dollars:

Coarse grain	$150–$160
Medium and fine grain	160– 180

Table 8.—Natural corundum: World production, by country
(Short tons)

Country [1]	1973	1974	1975 p
India	r 293	360	337
South Africa, Republic of	297	278	266
U.S.S.R. e	7,700	7,700	8,300
Uruguay	335	366	460
Total	r 8,625	8,704	9,363

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed, Southern Rhodesia presumably continued to produce natural corundum at a significant level (several thousand tons annually), and both Argentina and Kenya may have produced minor quantities of this commodity, but output is not reported and available information is inadequate for formulation of reliable estimates of output levels.

INDUSTRIAL DIAMOND

Domestic production of synthetic industrial diamond in 1975 was estimated to be 19 million carats, unchanged from that of 1974. Secondary production, comprising salvage from used diamond tools and from wet and dry diamond-containing wastes, was estimated to be 2 million carats subject to revision following a consumption canvass by the Department of Commerce.

The Government stockpile inventory as of December 31, 1975, was 33.6 million carats of crushing bort and 20.0 million carats of stones. The objectives for both categories are zero, and the inventories were considered excess. Available for disposal from prior enabling legislation were 9.9 million carats of bort. The inventory of small diamond dies was 25,473 of which the objective was 7,900 and 17,573 was excess.

Exports and reexports of industrial diamond dust and powder, which included synthetics, were 13.2 million carats valued at $33.0 million. Crushing bort, except dust and powder, exported was 374,000 carats valued at $2.0 million. Exports and reexports of stones were 3.4 million carats valued at $31.2 million. The total of exports and reexports of dust and powder, bort, and stones was 17.0 million carats valued at $66.3 million.

Table 9.—U.S. imports for consumption of industrial diamond (excluding diamond dies)
(Thousand carats and thousand dollars)

Year	Quantity	Value
1973	19,166	65,713
1974	r 18,417	62,920
1975	14,291	53,383

r Revised.

Table 10.—U.S. imports for consumption of industrial diamond, by country

(Thousand carats and thousand dollars)

Country	Crushing bort (including all types of bort suitable for crushing)				Other industrial diamond (including glazers' and engravers' diamond, unset)				Miners' diamond				Powder and dust			
	1974		1975		1974		1975		1974		1975		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Australia	--	--	--	--	(1)	3	(1)	8	--	--	--	--	--	--	--	--
Belgium-Luxembourg	35	75	--	--	1,009	5,283	370	1,477	5	27	6	54	326	595	191	248
Canada	r (1)	7	3	5	38	252	65	364	(1)	2	2	17	464	297	63	60
Central African Republic	--	--	--	--	37	464	4	14	1	4	--	--	--	--	--	--
Congo	--	--	--	--	273	685	66	301	--	--	--	--	--	--	(1)	(1)
France	--	--	--	--	12	278	9	299	--	--	(1)	8	--	--	11	25
Germany, West	--	--	1	3	2	42	5	55	--	--	(1)	(1)	8	20	111	159
Ghana	--	--	--	--	59	453	11	112	4	25	1	15	1	4	--	--
Gibraltar	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25	32
Hong Kong	--	--	--	--	--	--	--	--	--	--	6	35	--	--	--	--
Ireland	--	--	14	36	72	237	12	63	--	--	1	3	8,180	18,459	4,436	10,328
Israel	--	--	(1)	2	9	264	11	167	--	--	(1)	12	2	3	2	3
Japan	2	16	--	--	89	1,658	28	476	63	117	116	216	r 1,040	r 1,987	654	1,209
Mexico	--	--	--	--	1	8	--	--	--	--	--	--	17	32	15	25
Netherlands	16	35	108	208	472	3,312	89	852	12	55	--	--	36	77	53	173
Sierra Leone	--	--	--	--	--	--	10	198	--	--	3	15	--	--	--	--
South Africa, Republic of	70	160	157	413	1,475	9,383	2,648	18,404	1,194	6,000	742	4,262	16	38	1,408	3,562
Switzerland	--	--	--	--	40	182	(1)	16	2	24	--	--	r 152	r 163	78	92
U.S.S.R	--	--	(1)	(1)	--	--	60	78	--	--	--	--	556	746	671	910
United Kingdom	20	72	(1)	1	1,356	7,637	374	2,491	r 11	57	28	162	976	1,784	738	1,085
Venezuela	--	--	--	--	14	101	16	174	23	524	26	600	--	--	--	--
Western Africa n.e.c.[2]	--	--	--	--	78	848	305	1,961	--	--	--	--	1	3	220	243
Zaire	--	--	--	--	30	73	5	55	8	28	226	1,325	81	225	45	123
Other	--	--	--	--	13	46	8	71	1	20	9	49	15	30	25	29
Total	r 143	365	283	668	5,079	31,209	4,096	27,636	r 1,324	6,883	1,166	6,773	r 11,871	r 24,463	8,746	18,306

r Revised.
[1] Less than ½ unit.
[2] Prior to 1975, Western Portuguese Africa n.e.c.

WORLD REVIEW

Angola.—The financial strength of the Portuguese firm, Companhia de Diamantes de Angola (Diamang) deteriorated in 1974 and 1975.[2] Late deliveries, chaos at Angolan ports, the steady exodus of trained personnel, a breakdown in discipline and work output, and the collapse of public authority contributed to the decline. Diamang's production is derived from alluvial diamond-bearing gravels in areas drained by some of the principal river systems of central and southern Angola. Mechanical excavators and hydraulic monitors, as well as manual shovels, are used for stripping. In 1974 the volume of overburden removed was 12.96 million cubic yards, or 22% less than that of 1973. The volume of diamondiferous material treated at the plants serving the mines was less by 10% at 5.84 million cubic yards and production in 1974 of 1.96 million carats was 8% less than in 1973.

Botswana.—A new tax agreement regarding diamond mining at Orapa and Letlhakine (formerly the DK 1 and 2 complex) was announced by the Government of Botswana and DeBeers Botswana Mining Co. on July 23, 1975.[3] The agreement, for which negotiations took 2 years, provides for increasing Orapa's production to 4.5 million carats per year by 1979 from the present 2.4 million carats. The Letlhakine mine is expected to produce about 400,000 carats annually by 1979. Changes in the tax structure are expected to give the Government between 65% and 70% of diamond profits through taxes, royalties, and dividends. The Government's equity in the mining company will be increased from 15% to 50%. The Government and DeBeers will be equally represented on the company's board of directors. DeBeers will retain responsibility for technical supervision, and diamond production will continue to be marketed through the Central Selling Organization in London.

Brazil.—Anglo American Corp. (AAC) joined Icome (Bethlehem Steel Corp./Hanna Mining Co.) to form Sopermi (40% AAC, 60% Icome), an exploration firm which is active in Minas Gerais and Mato Grosso.[4] Results of a 4-year aerial infrared photographic survey of the Amazon region indicated areas suitable for prospecting for diamond in the Tumucumaque Mountains and in Roraima.

Central African Republic.—Diamond output in the Central African Republic attained a level of 339,000 carats in 1975 which was slightly above the 338,000 carats produced in 1974. The value of 1975 production was $14.7 million compared to $14.4 million in 1974. The 1975 value reflects the lower dollar exchange rates which prevailed in 1975 (diamonds are priced in dollars); however, stone quality and generally rising diamond prices more than compensated for this decrease.

All diamonds in the Central African Republic to date have been found in alluvial fans, basins, water courses and stream beds. As these formations are not conducive to large-scale mining operations, most diamonds are found by individuals and small groups. As panning and mining operations have continued over the years, diamonds have become increasingly more difficult to recover and mining now requires larger capital expenditures. In order to maintain and expand production, Diamond Distributors International (United States), COMINCO, Ltd. (Canada), and the Government of the Central African Republic established a local firm, Société Centrafricaine d'Exploitation Diamantifere (SCED), in late 1973 to mechanize mining and dredging operations and to provide technical assistance to artisanal diggers. SCED has had two successful years and has been largely responsible for maintaining diamond production at constant levels.

The quality of these diamonds is very good; 60% to 70% are of gem grade. Most stones are exported uncut to Europe, Israel, or the United States. About 5% of the diamonds are cut locally by skilled Central African artisans in Black Africa's only diamond cutting factory. Diamond exports to the United States totaled $6.8 million for gem stones and $464,000 for industrial diamonds in 1974. Diamonds comprise an important element in the foreign exchange earnings and tax revenues of the Central African Republic and the Government is vitally interested in maintaining and expanding production. Over the past decade diamonds have accounted for about 30% of the nation's foreign exchange earnings.

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[2] Mining Journal. Diamang. How Much Longer? V. 286, No. 7330, Feb. 13, 1976, p. 129.

[3] U.S. Bureau of Mines. Diamond: Botswana. Mineral Trade Notes, v. 72, No. 11, November 1975, p. 4.

[4] Mining Journal. AAC: Brazilian Diamond Interest. V. 284. No. 7295, June 13, 1975, p. 463.

Ghana.—In 1975 Cayco Ltd., Ghana Consolidated Diamond Ltd., (GCDL), Dunkwa Goldfields, and licensed individual diggers were mining diamonds in Ghana.[5] Amalgamated Diamond Corp. ceased production in late 1973, and Cayco's production has decreased significantly since 1968. Cayco's and GCDL's concessions are located in the Birim Basin of Eastern Ghana. Dunkwa Goldfields has a dredging operation on the Jimi River in the Ashanti region which recovers gem-quality stones in the 2- to 4-carat range. Gem stones are also found in the Bonsa Valley of Western Ghana but are generally too small for commercial purposes. About 90% of Ghana's production is industrial-grade diamonds. The First International Natura Corp., a New York-based company with substantial U.S. investment, is negotiating with the Government of Ghana to obtain mining rights in a 25-square-mile area at the confluence of the Birim and Pra Rivers. The Government will have a 55% equity in the project.

Diamond production is marketed exclusively by the Diamond Marketing Corp. (DMC). Its functions are to grade, value, and process diamonds as well as to buy all those won locally. All companies sell directly to DMC except GCDL, which sells through DMC. DMC sells diamonds to end users abroad with the assistance of Consolidated African Selection Trust Ltd. (CAST) in London. CAST owns 45% of GCDL. The majority of Ghana's diamonds are exported to the United Kingdom, the Netherlands, and Belgium-Luxembourg.

Lesotho.—Following almost 2 years of negotiations, Prime Minister Leabua Jonathan and DeBeers Consolidated Chairman Harry Oppenheimer signed an agreement which will open a new diamond mine in Lesotho.[6] The mine will be controlled by a newly formed company, DeBeers Lesotho Mining Co., Ltd., in which Lesotho will hold a 25% equity. DeBeers is committed to invest $35 million over 2 years.

The agreement permits development of Lesotho's only identified kimberlite diamond pipe at Letseng la Terae in the northeastern district of Mohkotlong. Mine production is expected to start in late 1976 or early 1977. Capacity will be approximately 4,400 tons per day. Site preparation has already started. Output will be marketed through a second company to be formed by DeBeers and registered in Lesotho.

According to the agreement, Lesotho will be able to charge a sales tax of about 15% on mine production until DeBeers recovers its capital costs. After that, Lesotho can continue to collect the sales tax on gross profits or 25% of profits after taxes plus 50% of the gross income, whichever is greater. Thus, if the mine proves profitable, Lesotho starts with a 62.5% share of the profits. If the profit ratio rises to previously agreed levels, the Government can increase taxes on profits to 62%, increasing its share to 71.5%.

Sierra Leone.—The 51% Government-owned National Diamond Mining Co. began prospecting new areas of the Southern Province to replace existing diamond deposit areas which are being mined out. An American firm, Diamond Distributors, International, Inc., of New York, acquired a prospecting license for diamond and gold.

South Africa, Republic of.—Diamond sales by the Central Selling Organization in 1975 were R793.5 million ($1.066 million), or 6.5% lower than in 1974.[7] During the period excess production was put into stocks and no breakdown was given for sales of either gem stones or industrial diamond. Sales of natural and synthetic industrial diamond were generally lower in 1975 than in 1974, but drilling products maintained the previous year's high level of sales. The nondiamond superhard abrasive, cubic boron nitride, was launched commercially under the name Amber Boron Nitride and is produced in South Africa.

At the dormant Kimberley mine the unusually heavy rains in recent years caused severe slope failures on the sides of the open pit mine. These were the first major ground movements of recent years and, to protect buildings and services in the adjacent areas, it was decided to construct a drainage tunnel to stabilize the ground. Work on this project commenced in November 1975 and is expected to be completed in 1977.

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[5] U.S. Bureau of Mines. Diamond: Ghana. Mineral Trade Notes, v. 72, No. 4, April 1975, pp. 14–15.

[6] U.S. Bureau of Mines. Diamond: Lesotho. Mineral Trade Notes, v. 72, No. 4, April 1975, pp. 15–16.

[7] DeBeers Consolidated Mines Limited. 1975 Annual Report. 59 pp. Printed in England by Burrup, Mathieson & Co., Ltd., London, Apr. 29, 1976.

U.S.S.R.—A major exhibition of industrial diamond and superhard tooling materials, Almaz–75 (Diamond–75), was staged in Moscow January 28 to February 18, 1975.[8] The exhibition, sponsored by the U.S.S.R. Ministry of Machine Tools and Tooling, was in the Chemical Industry Pavilion at the Permanent Exhibition of Economic Achievements, a complex on the northern outskirts of Moscow. According to Pravda the total material content of all tools in the show exceeded 260,000 carats. Various Soviet natural and synthetic diamond abrasive grits and finer sizes were displayed and some could be examined under a microscope. Virtually every facet of industrial diamond application was demonstrated live except frame and circular sawing of natural stone and concrete for which only the 6-foot-diameter saws and sawn products were displayed.

Zaire.—Société Minière de Bakwanga (MIBA) Zaire's state-owned diamond mining company, reported diamond production reached 12,990,558 carats in 1974, a substantial increase from the previous year's output of 12,004,498 carats. Sales totaled 23,314,841 Zaires (1 Zaire (Z) equals US$1), including Z450,007 from sales of exterior stock maintained in London in 1974. In 1973 total sales were Z22,447,168 based on 12,004,498 carats from current output and 1,254,048.50 carats released from the London stockpile. Despite the increased output, the volume of required earthmoving was only 5,064,238 cubic yards, a 14% decrease from total earth moved in 1973. MIBA plans to relocate part of the Mbuji-Mayi River to mine the riverbed during 1975.[9]

TECHNOLOGY

It is reportedly possible to synthesize diamond by growing it from existing diamonds in a low-pressure gas rich in carbon.[10] The fact that graphite and diamond have an identical natural composition suggested attempts to convert graphite into diamond by applying high pressure to graphite at high temperatures, the conditions under which natural diamond is assumed to form deep in the earth. This objective was attained in 1955 by a research and development group at the General Electric Co. After 1955 a group at the Institute of Physical Chemistry in Moscow explored the possibility of diamond synthesis at low pressure. They now claim a means of enlarging a seed crystal of diamond by exposing it to a carbonaceous gas at a pressure of less than 0.001 atmosphere.

The Mines Division of DeBeers Diamond Research Centre in Johannesburg, Republic of South Africa, reported progress on numerous projects among which were the following:[11]

As a replacement of a greasebelt circuit, a high-intensity magnetic separation pilot plant was installed at the Finsch mine for recovering diamond smaller than 3 millimeters from gravity concentrates.

A prototype magnetohydrostatic separation unit for final sorting was developed and operated at the Research Centre.

Froth flotation techniques for the primary recovery of fine diamond, smaller than 200 micrometers, were used successfully in the laboratory.

The selection of type II–A diamond from bulk diamond has been simplified with the installation of a new sorting device based on ultraviolet photography. Type II–A images are identified on film and a mechanism removes the corresponding stones from the grind. Type II–A diamonds are used as heat sinks in miniature electronic devices.

Diamond is used as a heat sink for semiconductor microwave devices because of its high thermal conductivity. The thermal conductivity of diamond heat sinks can be measured by determining temperature gradients with a radiation detector.[12] The results are accurate to 10% to 15%. Type II–A diamond is preferred for its high thermal conductivity.

Abstracts relative to properties of diamond hard materials, machines, and patents were published monthly in the Industrial Diamond Review. Each issue, January to December 1975, contained from 14 to 18 pages of abstracts and patent information.

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[8] Daniel, P. Almaz–75 Exhibition in Moscow—Soviet Diamond Tools on Display. Industrial Diamond Review, April 1975, pp. 142–143.

[9] U.S. Bureau of Mines, Diamond: Zaire. Mineral Trade Notes, v. 72, No. 11, November 1975, p. 4.

[10] Derjaguin, B. V., and D. B. Fedoauv. The Synthesis of Diamond at Low Pressure. Sci. Am., v. 233, No. 5, November 1975, pp. 102–109.

[11] DeBeers Consolidated Mines Limited. 1975 Annual Report. Printed in England by Burrup, Mathieson & Co., Ltd., London, p. 29.

[12] Burgemeister, E. A. The Thermal Conductivity of Diamond Heat Sinks. Ind. Diamond Rev., July 1975, pp. 242–244.

Table 11.—Diamond (natural): World production, by country [1]
(Thousand carats)

Country	1973			1974			1975 p		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	1,594	531	2,125	1,470	490	1,960	345	115	e 460
Botswana	362	2,054	2,416	408	2,310	2,718	362	2,052	2,414
Central African Republic	r 341	r 183	r 524	220	118	338	220	119	339
Ghana	r 231	r 2,076	r 2,307	257	2,315	2,572	233	2,095	2,328
Guinea e	25	55	80	25	55	80	25	55	80
Ivory Coast	120	180	300	112	167	279	84	125	209
Lesotho [2]	1	8	9	2	9	11	1	2	3
Liberia [3]	509	308	817	377	259	636	[4] 241	[4] 165	[4] 406
Sierra Leone	646	758	1,404	670	1,000	e 1,670	600	900	e 1,500
South Africa, Republic of:									
Premier mine	625	1,876	2,501	605	1,817	2,422	509	1,527	2,036
Other DeBeers properties [5]	2,368	1,938	4,306	2,397	1,961	4,358	2,518	2,061	4,579
Other	455	303	758	438	292	730	408	272	680
Total	3,448	4,117	7,565	3,440	4,070	7,510	3,435	3,860	7,295
South-West Africa, Territory of	1,520	80	1,600	1,491	79	1,570	1,660	88	1,748
Tanzania	251	250	501	249	249	498	224	224	448
Zaire	r 1,082	11,858	12,940	1,143	12,468	13,611	1,076	11,734	12,810
Other Areas:									
Brazil	r 56	r 57	r 113	127	127	254	135	135	e 270
Guyana	31	21	52	12	18	30	8	13	21
India	18	3	21	18	3	21	17	3	20
Indonesia e	12	3	15	12	3	15	12	3	15
U.S.S.R. e	1,900	7,600	9,500	1,900	7,600	9,500	1,950	7,750	9,700
Venezuela	315	463	778	279	970	1,249	239	821	1,060
World total	r 12,462	r 30,605	r 43,067	12,212	32,310	44,522	10,867	30,259	41,126

e Estimate. p Preliminary. r Revised.

[1] Total diamond output (gem plus industrial) for each country is actually reported except where indicated to be an estimate. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Central African Republic (1973), Lesotho (1973–1975), Liberia (1973 and 1974), Guyana (1973) and Venezuela (all years) where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

[2] Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

[3] Exports.

[4] Partial figure, January 1 through December 15 only.

[5] All company output from the Republic of South Africa except for that credited to the Premier mine; also excludes company output from the Territory of South-West Africa and Botswana.

ARTIFICIAL ABRASIVES

Five firms produced crude fused aluminum oxide in the United States and in Canada in 1975. Operators of plants in both countries were: The Carborundum Co., Norton Co., and General Abrasive Co., Division of U.S. Industries Inc. The Exolon Co. and Simonds Canada Abrasive Co, Ltd., operated plants in Canada. The production of white, high-purity material was 18,164 tons and production of regular grade was 122,828 tons. Of the combined output of white and regular, 12% was used for nonabrasive applications, principally in the manufacture of refractories. The production was 51% of the rated capacity of the furnaces used to produce fused aluminum oxide.

Two firms, The Carborundum Co. and General Abrasive Co., produced fused alumina zirconia abrasive in the United States and in Canada; and two firms, Norton Co. and Exolon Co., operated plants in Canada. All production was reportedly used for abrasive applications. The output was 48% of the capacity of the furnaces assigned to the production of fused alumina zirconia.

Six firms in the United States and in Canada produced silicon carbide in 1975. The Carborundum Co. operated plants in both countries. Electro-Refractories & Abrasives Canada, Ltd., Exolon Co., Norton Co., and General Abrasive Co., operated in Canada. These five companies produced crude for abrasive, refractory, and other nonabrasive uses. Satellite Alloy Corp. operated in the United States and produced crude for nonabrasive applications. Production by the six firms was 70% of capacity and 42% was reportedly used for abrasive applications. Nonabrasive use was 58% of the output and was mostly for refractory and metallurgical applications.

In the Stockpile Report to the Congress by the General Services Administration the inventory of crude fused aluminum oxide in calendar 1975 was reduced to 265,982 tons, uncommitted excess, a reduction of 1,080 tons as of December 31; the stock of aluminum oxide grain was unchanged at 50,905 tons; and the stock of silicon carbide crude was reduced by 38,246 tons to 80,619 tons, uncommitted excess.

Metallic abrasives were produced by 13 firms in the United States in 1975. Steel shot and grit comprised 74% of the total quantity sold or used; chilled iron shot and grit, 15%; annealed iron shot and grit, 11%; other metallic abrasives comprised the remainder. The amounts from Ohio were 32% of the total sold or used, the highest of the producing States. Michigan, Indiana, Pennsylvania, Alabama, New York, and Connecticut followed in quantity sold or used. Three companies recycled material: Copperweld Steel Co. of Glassport, Pa.; Industeel Corp. of Pittsburgh, Pa.; and Kohler Co. of Sheboygan, Wis.

Table 12.—Producers of metallic abrasives in 1975

Company	Location	Product shot and/or grit
Abbott Ball Co	West Hartford, Conn	Steel.
Abrasive Materials, Inc	Hillsdale, Mich	Steel and stainless steel cut wire.
Abrasive Metals Co	Pittsburgh, Pa	Chilled iron and annealed iron.
The Carborundum Co., Pangborn Div	Butler, Pa	Steel.
Cleveland Metal Abrasive Co	Birmingham, Ala	Do.
Do	Cleveland, Ohio	Do.
Do	Howell, Mich	Chilled iron.
Do	Springville, N. Y	Do.
Do	Toledo, Ohio	Steel.
Durasteel Co	Mt. Pleasant, Pa	Do.
Ervin Industries, Inc	Adrian, Mich	Chilled iron and steel.
Globe Steel Abrasive Co	Mansfield, Ohio	Chilled and annealed iron.
Metal Blast, Inc	Cleveland, Ohio	Do.
National Metal Abrasive Co	Do	Steel.
Pellets, Inc	Tonowanda. N. Y	Steel and stainless steel cut wire.
Steel Abrasives, Inc	Hamilton, Ohio	Chilled and annealed iron.
Wheelabrator-Frye Inc	Mishakawa, Ind	Steel.

TECHNOLOGY

Machine builders and grinding wheel users discussed the status of metrication in the grinding wheel industry at the 1975 Mid-Winter Conference of the Grinding Wheel Institute and the Abrasive Grain Association, February 4–5, 1975, Buffalo, N.Y.

Proponents of superabrasives claimed that a major part of the field of precision grinding of mild steels can be won by the superabrasives, diamond and cubic boron nitride.[13] The optimism of the proponents is not shared by some consumers because of the cost of the abrasive grain. For example, a pound of cubic boron nitride grain costs about $4,500 whereas a pound of silicon carbide costs 35 to 40 cents. However, the superabrasives outperform aluminum oxide and silicon carbide grinding wheels in both productivity and total costs.

The Manufacturing Development Staff of General Motors Corp. described progress on advanced abrasive machining concepts of grinding wheels up to 15 feet in diameter which would have cutting speed capability of 27,000 to 36,000 surface feet per minute.[14] The engineering development work must insure a safe system with regard to structural stiffness of the wheel versus vibration, retention of abrasive segments versus centrifugal force, and mechanical stability of the total installation versus machine part irregularities.

[13] Thornton, J. Superabrasive Debate Still Centers on CBN. Am. Metal Market and Metalworking News, v. 82, No. 245, Dec. 15, 1975, p. 20, 23.
[14] Wrigley, A. GM Revving Up Its Grinding. Am. Metal Market and Metalworking News, v. 82, No. 245, Dec. 15, 1975, p. 21–22.

Table 13.—Crude artificial abrasives produced in the United States and Canada
(Thousand short tons and thousand dollars)

Kind	1971	1972	1973	1974	1975
Silicon carbide [1]	130	166	162	163	134
Value	21,123	24,690	25,471	33,872	31,842
Aluminum oxide (abrasive grade) [1]	149	184	196	241	141
Value	24,514	28,590	27,339	40,906	28,368
Aluminum zirconium oxide	--	--	22	25	17
Value	--	--	6,223	9,839	8,506
Metallic abrasives [2]	193	235	266	301	236
Value	33,390	39,678	49,775	91,061	72,864
Total	472	585	646	730	528
Value	79,027	92,958	108,808	175,678	141,580

[1] Figures include material used for refractories and other nonabrasive purposes.
[2] Shipments for U.S. plants only.

Table 14.—Production, shipments, and annual capacities of metallic abrasives in the United States, by product

Year and product	Manufactured		Sold or used		Annual capacity [1] (short tons)
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	
1974:					
Chilled iron shot and grit	47,872	$8,460	50,966	$11,891	162,000
Annealed iron shot and grit	30,781	5,842	29,546	6,614	(2)
Steel shot and grit	215,800	57,233	217,427	71,389	240,650
Other [3]	3,166	829	3,247	1,167	10,760
Total	297,619	72,364	301,186	91,061	--
1975:					
Chilled iron shot and grit	28,352	5,539	34,904	8,428	124,593
Annealed iron shot and grit	23,967	5,086	25,010	7,004	49,640
Steel shot and grit	178,211	46,338	175,620	56,837	265,650
Other [3]	543	455	583	595	2,400
Total	231,073	57,418	236,117	72,864	--

[1] The total quantity of the various types of metallic abrasives that a plant could have produced during the year, working three 8-hour shifts per day, 7 days per week, allowing for usual interruptions, and assuming adequate fuel, labor, and transportation.
[2] Included in capacity of chilled iron shot and grit.
[3] Includes cut wire shot.

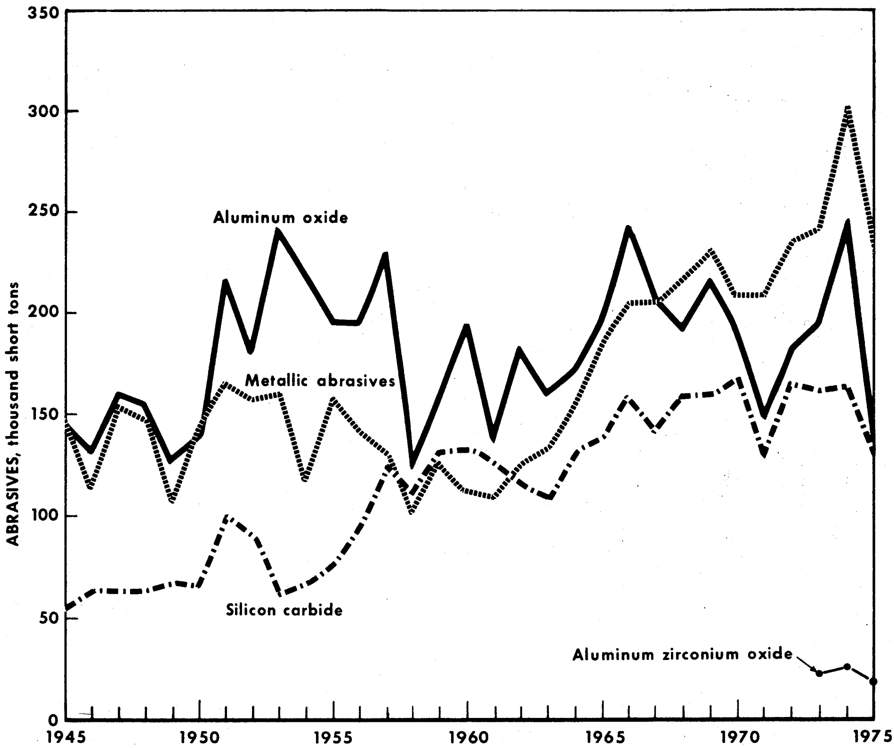

Figure 1.—Artificial abrasives production.

Aluminum

By John W. Stamper [1] and Christine M. Monroe [2]

Owing to the slowdown in economic activity throughout the world, world demand for aluminum was 15% below the 1974 level. This was the largest percentage decline in aluminum demand in modern times. Output of primary metal declined in all of the major producing countries except the United Kingdom and the U.S.S.R. Production was only 77% of yearend capacity in the United States, 86% in Canada, and 75% in Japan; however, relatively high operating rates were maintained in France and West Germany, and world production of primary aluminum was only 9% below that of 1974. World stocks of primary aluminum metal were estimated to have increased more than 50%. Total metal inventories increased 30%.

Production expansion plans in Canada, Norway, Japan, and New Zealand were delayed, but new projects in Canada, Brazil, Abu Dhabi, Saudi Arabia, and the Republic of Korea were announced. Construction of new alumina reduction plants was started in Venezuela, Dubai, and Japan.

Table 1.—Salient aluminum statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Primary production	3,925	4,122	4,529	4,903	3,879
Value	$2,154,446	$2,084,946	$2,206,440	$3,005,640	$2,976,427
Price: Ingot, average cents per pound	29.0	26.3	25.3	34.1	39.8
Secondary recovery	816	946	1,040	993	980
Exports (crude and semicrude)	293	329	561	524	439
Imports for consumption (crude and semicrude)	690	794	614	629	550
Consumption, apparent	5,099	5,588	5,685	r 5,918	4,737
World: Production	11,373	12,133	r 13,364	r 14,528	13,273

r Revised.

U.S. aluminum demand, as measured by net shipments of aluminum ingot and mill products to domestic industry, dropped almost 30%. Despite a 21% reduction in the output of primary metal, equivalent to a million tons less than in 1974, total metal inventories held by the domestic industry at yearend 1975 increased by 422,000 tons and were almost 20% greater than the inventory held at the beginning of the year.

Legislation and Government Programs.—The shipment of 2,486 tons of primary aluminum from government inventories during 1975 under the aluminum disposal program that became effective November 23, 1965, brought the total shipped under the program to 1,866,970 tons.

On July 11, 1975, the Council on Wage and Price Stability requested the aluminum industry to delay the price increases for primary aluminum ingot, which the industry had announced at midyear, until August 7 so that the Council could study the justification for the increases. After hearing the industry's statements on July 21

[1] Physical scientist, Division of Nonferrous Metals.
[2] Statistical assistant, Division of Nonferrous Metals.

and 22, the Council concluded that it would not request any further delay in the price increases and indicated that the rising costs of producing aluminum were well documented. The price rise was implemented on August 11.

DOMESTIC PRODUCTION

Primary.—Domestic primary aluminum production capacity increased slightly during 1975 to 5,021,000 tons. However, owing to decreased demand, primary smelters operated at 74% of rated capacity during the second half of the year, and primary production decreased 21% from the 1974 level. Of the major producers, Aluminum Company of America (Alcoa) cut production by 26%, Kaiser Aluminum & Chemical Corp. (Kaiser) by 27%, and Reynolds Metals Co. (Reynolds) by 33%. The Anaconda Aluminum Co. (Anaconda) operated at 70% of rated capacity, and Martin Marietta Aluminum, Inc., at 81%.

Alcoa announced the startup of part of a new 130,000-ton-per-year potline at its Massena, N.Y., smelter. The new unit replaced three older lines and reportedly used 10% less energy per pound of aluminum produced than the older lines. Alcoa also announced the postponement of plans to double the capacity of its lignite-fired powerplant at Rockdale, Tex.

The Pechiney Ugine Kuhlmann Group (PUK) acquired the remaining 30% interest in the Howmet Corp., which owned both 50% of the Eastalco Aluminum Co. smelter at Frederick, Md., and 50% of the Italco Aluminum Corp. plant at Ferndale, Wash. The remaining 50% of each plant was owned by Alumax, Inc., which in turn was owned 50% by AMAX Inc., 45% by Mitsui & Co. Ltd., and 5% by Nippon Steel.

Table 2.—Production and shipments of primary aluminum in the United States
(Short tons)

Quarter	1974		1975	
	Production	Shipments	Production	Shipments
First	1,199,623	1,201,575	1,065,709	869,788
Second	1,236,227	1,234,597	954,900	846,368
Third	1,228,569	1,224,291	918,613	949,557
Fourth	1,239,007	1,159,991	939,924	981,392
Total	4,903,426	4,820,454	3,879,146	3,647,105

Table 3.—Primary aluminum production capacity in the United States, by company
(Thousand short tons)

Company and plant	Capacity at yearend 1975	Ownership
Aluminum Company of America (Alcoa):		Self 100%.
Alcoa, Tenn; Badin, N.C; Evansville, (Warrick), Ind; Massena, N.Y; Point Comfort, Tex; Rockdale, Tex; Vancouver, Wash; Wenatchee, Wash	1,575	
Total	1,575	
Anaconda Aluminum Co.:		Self 100%.
Columbia Falls, Mont	180	
Sebree, Ky	120	
Total	300	

Table 3.—Primary aluminum production capacity in the United States, by company—Continued
(Thousand short tons)

Company and plant	Capacity at yearend 1975	Ownership
Consolidated Aluminum, Inc.:		Swiss Aluminium Ltd. 60%; Phelps Dodge Corp. 40%.
Lake Charles, La	36	
New Johnsonville, Tenn	141	
Total	177	
Eastalco Aluminum Co.:		
Frederick, Md	176	Alumax, Inc. (AMAX Inc. 50%; Mitsui & Co. Ltd. 45%; Nippon Steel 5%) 50%; Pechiney Ugine Kuhlmann 50%.
Intalco Aluminum Corp.:		Do.
Ferndale (Bellingham), Wash	260	
Kaiser Aluminum & Chemical Corp.:		Self 100%.
Chalmette, La	260	
Mead, Wash	220	
Ravenswood, W. Va	163	
Tacoma, Wash	81	
Total	724	
Martin Marietta Aluminum, Inc.:		Martin Marietta Corp. 87.2%; private interest 12.8%.
Goldendale, Wash	120	
The Dalles, Oreg	90	
Total	210	
National-Southwire Aluminum Co.:		
Hawesville, Ky	180	National Steel Corp. 50%; Southwire Co. 50%.
Noranda Aluminum, Inc.:		
New Madrid, Mo	70	Noranda Mines, Ltd. 100%.
Ormet Corp.:		
Hannibal, Ohio	260	Swiss Aluminium Ltd. 40%; Revere Copper & Brass Inc. 34%; Phelps Dodge Corp. 26%.
Revere Copper & Brass, Inc.:		
Scottsboro, Ala	114	Self 100%.
Reynolds Metals Co.:		Self 100%.
Arkadelphia, Ark	68	
Corpus Christi (San Patricio), Tex	114	
Jones Mills, Ark	125	
Listerhill (Sheffield), Ala	202	
Longview, Wash	210	
Massena, N.Y	126	
Troutdale, Oreg	130	
Total	975	
Total United States	5,021	

Alumax, Inc., announced the completion of an 87,600-ton-per-year potline at Frederick, Md., bringing total capacity of the Eastalco plant to 176,000 tons per year. Ownership of the facility at yearend consisted of Alumax, Inc., 50% and PUK, 50%. Alumax obtained the required Federal and State permits for a 187,000-ton-per-year smelter at Umatillo, Oreg., but encountered further delays when the Federal district court ordered that the company postpone signing a power contract with the Bonneville Power Administration until an environmental impact report had been filed. Nippon Steel purchased 5% of the Mitsui Aluminum Co. Ltd. 50% interest in Alumax, Inc., for $14.6 million.

The Japanese consortium consisting of Sumitomo Chemical Co., Ltd., Kobe Steel Ltd., Nippon Light Metal Co., Ltd., Marubeni Corp., Sumitomo Shoji Kaishe Ltd., and Kanematsu Gosho KK, withdrew from the Revere Copper & Brass, Inc., 120,000-ton-per-year expansion at Revere's Scottsboro, Ala., smelter.

The Aluminum Association announced that since 1972 the aluminum industry had reduced energy consumption 6.5% per pound of aluminum produced. The aluminum industry set a goal of reducing energy consumption 10% between 1972 and 1980.

Secondary.—Recovery of secondary aluminum-base scrap, calculated from reports to the Bureau of Mines, was 980,340 tons, slightly less than the quantity recovered in 1974. Calculated recovery of all metallic constituents from aluminum-base scrap in 1975 declined slightly to 1,048,875 tons.

The Bureau estimated that full coverage of the industry would indicate a total scrap consumption of 1,448,000 tons in 1975. On this basis, aluminum recovery would total 1,156,000 tons, and total metallic recovery would be 1,239,000 tons.

U.S. Reduction Co. announced plans to construct a $3 million plant to separate salt from aluminum slag, at a rate of 50,000 tons per year. In November, American Can Co. signed a letter of intent to purchase the U.S. Reduction Co. for approximately $36 million. U.S. Reduction was the largest independent secondary aluminum smelter operation in the United States.

Decreased demand and increased inventories forced many secondary aluminum producers to reduce operations during the year. U.S. Reduction closed the Alton, Ill., secondary smelter during July.

Recycling technology developed by the Bureau of Mines was scheduled to be the nucleus of three new urban refuse recycling plants that will recover significant quantities of aluminum-base scrap. A plant in Montgomery County, Md., was scheduled to have a 1,200-ton-per-day capacity initially and was to be expanded to 2,000 tons per day by 1985. A recycling plant in Baltimore, Md., was under construction and was scheduled to begin operating in 1976. The plant in Montgomery County, Md., and one in Monroe County, N.Y., were in the design phase, and were scheduled to open in 1977 and 1978, respectively.

Table 4.—Aluminum recovered from purchased scrap processed in the United States, by kind of scrap and form of recovery
(Short tons)

Kind of scrap	1974	1975	Form of recovery	1974 [r]	1975
New scrap:			Unalloyed	4,336	4,519
Aluminum-base	[1]779,978	[2]696,698	Aluminum alloys	921,678	914,523
Copper-base	86	66	In brass and and bronze	121	77
Zinc-base	112	119	In zinc-base alloys	776	978
Magnesium-base	270	231	In magnesium alloys	528	509
			Dissipative forms [3]	65,992	59,734
Total	780,446	697,114	Total	993,431	980,340
Old scrap:					
Aluminum-base	[1]211,987	[2]282,044			
Copper-base	76	45			
Zinc-base	664	859			
Magnesium-base	258	278			
Total	212,985	283,226			
Grand total	993,431	980,340			

[r] Revised.
[1] Aluminum alloys recovered from aluminum-base scrap in 1974, including all constituents, were 821,538 tons from new scrap and 236,553 tons from old scrap and sweated pig, a total of 1,058,091 tons.
[2] Aluminum alloys recovered from aluminum-base scrap in 1975, including all constituents, were 742,993 tons from new scrap and 305,882 tons from old scrap and sweated pig, a total of 1,048,875 tons.
[3] Includes recovery in deoxidizing ingot assuming 85% aluminum content in such ingot.

Table 5.—Consumption of and recovery from purchased new and old aluminum scrap in 1975 [1]
(Short tons)

Class	Consumption	Calculated recovery	
		Aluminum	Metallic
Secondary smelters	611,540	488,358	524,842
Primary producers	336,328	298,691	319,779
Fabricators	98,001	86,830	92,747
Foundries	72,099	62,447	66,834
Chemical producers	107,705	42,416	44,673
Total	1,225,673	978,742	1,048,875
Estimated full industry coverage	1,448,0000	1,156,000	1,239,000

[1] Excludes recovery from other than aluminum-base scrap.

Table 6.—Stocks, receipts, and consumption of purchased new and old aluminum scrap and sweated pig in the United States in 1975 [1]

(Short tons)

Class of consumer and type of scrap	Stocks Jan. 1 [r]	Net receipts [2]	Consumption	Stocks Dec. 31
Secondary smelters:				
New scrap:				
Solids and clippings	19,754	184,550	188,904	15,400
Borings and turnings	10,543	122,295	124,431	8,407
Foil	52	1,120	734	438
Dross and skimmings	8,644	91,441	93,784	6,301
Other	1,157	14,050	14,544	663
Total new scrap	40,150	413,456	422,397	31,209
Old scrap:				
Castings, sheet, and clippings	6,090	92,034	85,628	12,496
Aluminum cans	737	6,867	6,943	661
Other [3]	2,905	30,617	31,585	1,937
Total old scrap	9,732	129,518	124,156	15,094
Sweated pig	15,032	71,692	64,987	21,737
Total all classes	64,914	614,666	611,540	68,040
Primary producers, foundries, fabricators, and chemical plants:				
New scrap:				
Solids and clippings	48,690	331,160	334,060	45,790
Borings and turnings	70	2,650	2,519	201
Foil	573	6,626	6,690	509
Dross and skimmings	2,934	92,001	92,393	2,542
Other	552	36,687	37,002	237
Total new scrap	52,819	469,124	472,664	49,279
Old scrap:				
Castings, sheet, and clippings	2,006	28,088	27,608	2,486
Aluminum cans	389	83,294	76,892	6,791
Other [3]	559	18,086	18,162	483
Total old scrap	2,954	129,468	122,662	9,760
Sweated pig	3,815	22,870	25,289	1,396
Total all classes	59,588	621,462	620,615	60,435
Total of all scrap consumed:				
New scrap:				
Solids and clippings	68,444	515,710	522,964	61,190
Borings and turnings	10,613	124,945	126,950	8,608
Foil	625	7,746	7,424	947
Dross and skimmings	11,578	183,442	186,177	8,843
Other	1,709	50,737	51,546	900
Total new scrap	92,969	882,580	895,061	80,488
Old scrap:				
Castings, sheet, and clippings	8,096	120,122	113,236	14,982
Aluminum-copper radiators	814	8,444	8,270	988
Aluminum cans	1,126	90,161	83,835	7,452
Other	2,650	40,259	41,477	1,432
Total old scrap	12,686	258,986	246,818	24,854
Sweated pig	18,847	94,562	90,276	23,133
Total all classes	124,502	1,236,128	1,232,155	128,475

[r] Revised.
[1] Includes imported scrap. The reporting companies reported that 7.84% of total receipts of aluminum-base scrap, or 96,971 tons, was received on toll arrangements; 1.65% of total receipts, or 20,335 tons, was imported directly by consumers.
[2] Includes inventory adjustment.
[3] Includes data on aluminum-copper radiators.

Table 7.—Production and shipments of secondary aluminum alloys by independent smelters

(Short tons) [1]

	1974 [2]		1975 [2]	
	Production	Shipments	Production	Shipments
Die-cast alloys:				
13% Si, 360, etc. (0.6% Cu, maximum)	50,642	48,198	55,868	49,204
380 and variations	340,248	329,252	282,054	283,568
Other	(3)	(3)	W	W
Sand and permanent mold:				
95/5 Al-Si, 356, etc. (0.6% Cu, maximum)	29,094	28,371	19,401	18,387
No. 12 and variations	21,406	21,258	12,408	12,196
No. 319 and variations	52,728	52,039	36,982	36,452
F-132 alloy and variations	(3)	(3)	13,607	13,777
Al-Mg alloys	4,236	4,180	1,595	1,495
Al-Zn alloys	10,374	9,876	9,873	9,433
Al-Si alloys (0.6% to 2.0% Cu)	4,771	4,609	4,219	4,309
Al-Cu alloys (1.5% Si, maximum)	4,871	4,859	4,667	4,883
Al-Si-Cu-Ni alloys	6,250	6,181	W	W
Other	(3)	(3)	3,608	3,601
Wrought alloys:				
Extrusion billets	(4)	(4)	48,454	49,536
Destructive and other uses:				
Steel deoxidation:				
Grades 1 and 2	27,172	26,596	17,474	18,767
Grades 3 and 4	5,134	5,270	2,900	3,005
Miscellaneous:				
Pure (97.0% Al)	99,587	95,982	4,517	630
Aluminum-base hardeners	4,542	4,468	2,954	3,021
Other [5]	18,407	18,557	27,038	26,471
Total	679,462	659,696	547,619	538,745

W Withheld to avoid disclosing individual company confidential data. Data included in the miscellaneous, other category.

[1] Gross weight, including copper, silicon, and other alloying elements. Secondary smelters used 39,301 and 16,902 tons of primary aluminum in 1974 and 1975, respectively, in producing secondary aluminum-base alloys.

[2] No allowance was made for consumption or receipts by producing plants.

[3] Not reported separately prior to 1975; probably included in the miscellaneous, other category.

[4] Included under the miscellaneous, Pure (97.0% Al) category.

[5] Includes alloys 122 and 138, reported as separate items prior to 1975, and data withheld.

CONSUMPTION

Domestic consumption as measured by net shipments of aluminum ingot and mill products to domestic industry was 29% below the 1974 level. Shipments to the building and construction industry, the largest user of aluminum, decreased 29% from 1974 shipments. The containers and packaging industry was the second largest user of aluminum with shipments totaling 1,000,500 tons, 12% less than the 1974 level. Transportation applications decreased 30%, and shipments to electrical markets also decreased markedly.

The average quantity of aluminum used in 1975 model automobiles was approximately 84 pounds per car, and reported estimates indicated that 1976 models would use 87 pounds per unit. By 1980 between 180 and 200 pounds was expected to be required per unit.

Although shipments of sheet to can manufacturers decreased, aluminum was reportedly used for about 25% of the metal cans manufactured in 1975, compared with about 20% in 1974, 17% in 1972, and 10% in 1970.

Table 8.—Distribution of end use shipments of aluminum products

Industry	1974 r		1975	
	Quantity (thousand short tons)	Percent of total	Quantity (thousand short tons)	Percent of total
Building and construction	1,573	22.9	1,123	22.6
Transportation	1,220	17.8	855	17.2
Containers and packaging	1,133	16.5	1,000	20.2
Electrical	922	13.4	608	12.2
Consumer durables	580	8.5	377	7.6
Machinery and equipment	522	7.6	325	6.6
Other markets	374	5.4	262	5.3
Statistical adjustment	70	1.0	5	.1
Total to domestic users	6,394	93.1	4,555	91.8
Exports	472	6.9	409	8.2
Total	6,866	100.0	4,964	100.0

r Revised.

Source: The Aluminum Association.

Table 9.—Apparent consumption of aluminum in the United States

(Short tons)

Year	Primary sold or used by producers [1]	Imports (net) [2]	Recovery from old scrap [3]	Recovery from new scrap [3]	Total apparent consumption [1]
1971	3,887,429	+396,408	167,030	648,138	5,099,005
1972	4,177,190	+466,765	188,594	755,762	5,588,311
1973	4,587,348	+59,484	196,514	841,966	5,685,312
1974	4,820,454	r +105,417	211,987	779,978	r 5,917,836
1975	3,647,104	+111,653	282,044	696,698	4,737,499

r Revised.

[1] Excludes primary aluminum sold by General Services Administration: 1971, 22 tons; 1972, 6,125 tons; 1973, 730,249 tons; 1974, 510,741 tons; and 1975, 2,486 tons.

[2] Crude and semicrude data for 1971–73 include ingot equivalent of scrap imports and exports (weights multiplied by 0.9). Reported data for 1974 and 1975 include imports of scrap.

[3] Aluminum content.

Table 10.—Net shipments of aluminum wrought [1] and cast products by producers

(Short tons)

	1974	1975 p
Wrought products:		
Sheet, plate, and foil	r 3,187,208	2,330,980
Rolled and continuous-cast rod and bar; wire	r 696,240	461,723
Extruded rod, bar, pipe, tube, shapes; drawn and welded tubing and rolled structural shapes	r 1,191,962	821,802
Powder, flake, and paste	88,584	49,428
Forgings (including impacts)	69,156	48,550
Total	r 5,233,150	3,712,483
Castings:		
Sand	133,911	96,776
Permanent mold	188,544	141,370
Die	544,228	427,553
Others	13,052	13,368
Total	879,735	679,067
Grand total	r 6,112,885	4,391,550

p Preliminary. r Revised.

[1] Net shipments derived by subtracting the sum of producers' domestic receipts of each mill shape from the domestic industry's gross shipment of that shape.

Source: Department of Commerce.

Table 11.—Distribution of wrought products

(Percent)

	1974	1975 p
Sheet, plate, and foil:		
Non-heat-treatable	50.2	51.5
Heat-treatable	3.6	3.1
Foil	7.1	8.2
Rolled and continuous-cast rod and bar; wire:		
Rod, bar, etc	2.6	2.5
Bare wire, conductor and nonconductor	1.3	.9
Bare cable (including steel-reinforced)	5.2	5.7
Wire and cable, insulated or covered	4.3	3.3
Extruded products:		
Rod and bar	.6	.9
Pipe and tubing	2.1	1.9
Shapes [1]	17.9	17.7
Tubing:		
Drawn	1.1	.9
Welded, non-heat-treatable [2]	1.1	.8
Powder, flake, and paste:		
Atomized	1.2	.9
Flaked	(3)	(3)
Paste	.2	.3
Powder, n.e.c	.2	.1
Forgings (including impacts)	1.3	1.3
Total	100.0	100.0

p Preliminary.
[1] Includes a small amount of rolled structural shapes.
[2] Includes a small amount of heat-treatable welded tube.
[3] Less than 0.1%.

STOCKS

Due to increased demand, reported industry stocks of primary aluminum ingot at reduction plants increased dramatically from 145,757 tons at the beginning of the year to 379,564 tons at yearend. A peak of 450,211 tons was reached at the end of June. The Bureau of Domestic Commerce (BDC) reported an increase in metal inventories at reduction and other processing plants. Total industry stocks of aluminum metal, including scrap, increased from 2,577,758 tons at the beginning of the year to 2,999,352 tons at yearend.

PRICES

The price of 99.5% pure primary aluminum was quoted at 39.0 cents per pound from January 1 until August 7, when producers, after hearings before the Council on Wage and Price Stability, raised the price to 41.0 cents per pound. Dealer quotes for primary aluminum increased from a range of 35.0 to 35.5 cents per pound at the beginning of the year to a maximum range of 37.0 to 38.5 cents per pound during August, and then declined to a range of 34 to 35 cents per pound at yearend. Prices quoted by the American Metal Market for smelters' secondary aluminum alloys decreased from a range of 47.0 to 58.0 cents per pound at the beginning of the year to a range of 40.5 to 50.0 cents per pound at yearend.

FOREIGN TRADE

Reflecting weak world demand, exports of crude and semicrude aluminum metal including scrap decreased about 16% from the 1974 level. Canada was the principal destination of U.S. aluminum exports. The People's Republic of China received 37%, or 68,906 tons, of the primary aluminum ingot exports. Japan was the principal destination of U.S. scrap exports with 22,558 tons, or 34%. Mexico and the United Kingdom were other major recipients of U.S. aluminum exports.

U.S. imports for consumption of crude and semicrude aluminum decreased 13% from the 1974 level. Scrap imports were off 27%, but imports of semimanufactured forms increased sharply with Belgium, Norway, and Japan increasing their shipments to the United States during 1975. Principal sources of aluminum imports were Canada, Ghana, Belgium, Japan, Surinam, and the U.S.S.R.

Table 12.—U.S. exports of aluminum, by class

Class	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Crude and semicrude:				
Ingots, slabs, crude	r 207,829	$155,817	185,850	$134,064
Scrap	80,159	33,043	65,747	29,085
Plates, sheets, bars, etc	216,030	247,976	171,008	228,684
Castings and forgings	5,933	19,623	5,008	18,813
Semifabricated forms, n.e.c	14,094	r 25,781	11,013	25,593
Total	r 524,045	r 482,240	438,626	436,239
Manufactures:				
Foil and leaf	16,770	31,206	11,604	24,185
Powders and pastes	4,366	5,384	3,460	5,434
Wire and cable	12,274	16,526	24,416	35,329
Total	33,410	53,116	39,480	64,948
Grand total	557,455	535,356	478,106	501,187

r Revised.

Table 13.—U.S. exports of aluminum, by class and country

Country	1974						1975					
	Ingots, slabs, crude		Plates, sheets, bars, etc.[1]		Scrap		Ingots, slabs, crude		Plates, sheets, bars, etc.[1]		Scrap	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	10,804	$7,190	283	$313	212	$202	6,298	$5,060	702	$1,156	--	--
Australia	238	352	4,070	5,195	--	--	109	100	882	2,217	--	--
Belgium-Luxembourg	564	307	533	1,178	1,245	949	40	18	507	1,303	2,164	$1,028
Brazil	16,043	14,122	4,659	6,513	4,011	1,962	3,469	2,838	4,369	7,112	2,451	952
Canada	39,411	28,533	102,058	117,570	10,280	3,992	17,901	12,591	65,024	83,861	8,413	3,064
Chile	792	769	125	154	3	2	147	141	165	257	--	--
China, People's Republic of	--	--	2	16	--	--	68,906	46,292	279	528	--	--
Colombia	861	816	153	248	3	2	641	574	55	115	3	3
Denmark	1	2	3,647	4,301	--	--	12	25	4,286	5,378	--	--
El Salvador	2,849	2,219	373	488	1	1	726	650	380	492	--	--
France	2,728	2,309	1,763	2,764	1,520	886	6,711	5,026	1,598	2,870	498	320
Germany, West	4,558	2,892	10,266	14,536	10,902	5,528	830	682	7,841	12,072	15,436	6,269
Ghana	1	([2])	199	272	--	--	44	36	302	417	--	--
Guinea	--	--	1,481	1,354	--	--	--	--	1,505	1,797	--	--
Hong Kong	769	583	829	1,111	187	9	74	99	201	392	--	--
India	4	2	32	79	--	--	1,876	1,269	18	80	--	--
Iran	2	1	1,182	1,481	--	--	1,102	889	259	779	--	--
Israel	1,915	1,562	2,592	4,936	--	--	434	707	2,672	6,356	8	19
Italy	1,313	1,265	7,389	13,211	5,145	1,223	412	564	3,700	10,308	2,173	930
Japan	59,685	43,234	14,429	18,167	16,465	9,918	46,364	31,734	10,441	17,941	22,558	11,368
Korea, Republic of	2,317	1,919	1,676	1,815	1,236	685	687	490	1,486	3,391	716	305
Mexico	19,212	16,155	18,596	17,720	624	300	8,272	6,570	22,254	22,855	197	25
Netherlands	6,540	3,848	6,973	8,814	717	397	1,319	1,043	7,149	11,275	2,400	999
New Zealand	37	50	1,505	2,492	--	--	13	12	541	966	--	--
Nigeria	18	45	276	370	--	--	427	755	134	356	--	--
Norway	1,597	857	3,516	5,206	--	--	46	52	11,027	15,699	3	2
Pakistan	5,074	4,070	1,363	2,474	161	102	87	62	114	51	2,124	1,377
Panama	905	527	241	379	10	6	788	574	80	160	--	--
Peru	177	199	22	68	415	324	135	134	22	98	541	338
Philippines	10,293	7,410	145	388	94	81	6,904	5,435	152	462	47	43
Portugal	301	262	311	491	--	--	4	2	346	536	4	1
Saudi Arabia	37	29	828	1,150	--	--	9	30	828	1,765	--	--
Singapore	1,351	931	250	420	--	--	10	11	636	1,022	--	--
South Africa, Republic of	21	34	4,722	5,175	--	--	5	16	4,909	6,950	57	32
Spain	217	219	819	1,225	552	285	100	48	1,103	1,567	1,810	990
Sweden	202	79	1,254	1,752	--	--	5	10	567	1,306	101	47
Switzerland	582	302	492	831	106	89	14	7	144	717	([2])	25

Taiwan	4,484	2,706	1,585	2,449	23,883	3,569	5,647	4,434	899	2,090	3,379	572
Thailand	4,880	3,483	209	310	353	238	2,807	2,060	228	487	--	--
United Kingdom	1,693	1,365	22,453	28,249	1,633	860	946	1,225	18,191	27,404	305	174
Venezuela	161	294	3,657	4,443	6	3	50	184	6,128	7,717	--	--
Other	5,192	4,875	9,099	r 13,272	395	1,430	1,479	1,615	4,905	10,785	359	202
Total	207,829	155,817	236,057	r 293,380	80,159	33,043	185,850	134,064	187,029	273,090	65,747	29,085

r Revised.
[1] Includes plates, sheets, bars, extrusions, forgings, and unclassified semifabricated forms.
[2] Less than ½ unit.

Table 14.—U.S. imports for consumption of aluminum, by class

Class	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Crude and semicrude:				
Metals and alloys, crude	508,643	$312,479	434,119	$316,873
Circles and disks	5,817	5,614	5,246	6,018
Plates, sheets, etc., n.e.c	29,351	28,210	48,763	48,656
Rods and bars	10,098	11,952	6,903	8,474
Pipes, tubes, etc	815	1,713	442	1,931
Scrap	74,743	42,569	54,806	27,586
Total	629,467	402,537	550,279	409,538
Manufactures:				
Foil	6,818	17,259	2,281	7,715
Leaf (5.5 by 5.5 inches)	(1)	105	(1)	79
Flakes and powders	428	649	318	364
Wire	986	1,313	752	882
Total	8,232	19,326	3,301	9,040
Grand total	637,699	421,863	553,580	418,578

[1] 1974—3,033,889 leaves and 184,868,315 square inches; 1975—582,500 leaves and 87,658,158 square inches.

Table 15.—U.S. imports for consumption of aluminum, by class and country

Country	1974 Metals and alloys, crude: Quantity (short tons)	1974 Metals and alloys, crude: Value (thousands)	1974 Plates, sheets, bars, etc.[1]: Quantity (short tons)	1974 Plates, sheets, bars, etc.[1]: Value (thousands)	1974 Scrap: Quantity (short tons)	1974 Scrap: Value (thousands)	1975 Metals and alloys, crude: Quantity (short tons)	1975 Metals and alloys, crude: Value (thousands)	1975 Plates, sheets, bars, etc.[1]: Quantity (short tons)	1975 Plates, sheets, bars, etc.[1]: Value (thousands)	1975 Scrap: Quantity (short tons)	1975 Scrap: Value (thousands)
Australia	562	$388	9	$14	724	$395	--	--	5	$11	--	--
Austria	1	(2)	2,086	2,142	--	--	19	$20	1,254	1,328	--	--
Belgium-Luxembourg	50	43	11,217	10,265	145	90	214	150	21,950	21,639	--	--
Canada	408,280	247,499	3,670	4,508	48,847	25,790	338,468	244,574	3,427	5,347	32,239	$17,917
Finland	--	--	--	--	--	--	--	--	1,076	350	--	--
France	2,682	2,347	6,757	5,842	--	--	4,815	3,111	5,081	6,977	--	--
Germany, West	2,391	2,072	1,922	2,528	4,719	3,392	2,488	1,904	836	1,287	6,673	2,966
Ghana	56,654	34,036	--	--	--	--	62,389	47,879	--	--	--	--
Greece	--	--	1,782	1,773	--	--	--	--	88	94	--	--
Hong Kong	20	13	52	51	1,477	1,035	--	--	689	715	18	12
Italy	--	--	2,594	2,483	17	14	--	--	1,647	1,714	15	7
Japan	10,177	8,380	6,556	8,065	2,538	1,686	842	912	15,104	15,230	249	179
Mexico	174	76	6	15	1,325	476	136	49	7	13	1,742	474
Norway	14,393	8,759	406	384	766	589	3,761	3,734	2,645	2,293	--	--
Spain	--	--	2,008	1,577	--	--	134	80	1,095	1,129	72	26
Surinam	7,609	4,385	--	--	--	--	13,030	9,465	18	12	--	--
Sweden	220	170	53	110	--	--	282	191	105	194	--	--
Switzerland	--	--	28	58	--	--	(2)	(2)	25	86	110	72
U.S.S.R	2	14	--	--	--	--	22	90	--	--	10,176	4,044
United Kingdom	3,117	2,415	508	617	8,505	5,864	6,631	4,135	264	464	2,565	1,437
Vietnam, South	473	302	--	--	776	491	327	213	--	--	11	5
Yugoslavia	1,213	1,125	6,150	6,723	428	333	551	358	5,581	5,770	--	--
Other	625	455	277	334	4,476	2,414	10	8	457	476	936	447
Total	508,643	312,479	46,081	47,489	74,743	42,569	434,119	316,873	61,354	65,079	54,806	27,586

[1] Includes circles, disks, bars, rods, plates, sheets, pipes, etc.
[2] Less than ½ unit.

WORLD REVIEW

As demand slackened during 1975, stocks of primary aluminum held by members of the International Primary Aluminium Institute (IPAI) increased dramatically. IPAI member stocks, which represent the bulk of inventories held outside the centrally controlled economies, increased 55% over 1974 levels. The peak level was reached during the third quarter, and members' stocks decreased slightly by yearend.

Production rates at primary smelters reportedly were reduced in many countries. At yearend, Canada operated at about 86% of total capacity, Norway at 89%, West Germany at 90%, France at 94%, Japan at 75%, and Australia at 93%.

Expansion plans in Canada, Norway, Japan, and New Zealand were delayed. However, new projects were announced in Canada, Brazil, Zaire, Abu Dhabi, Saudi Arabia, and the Republic of Korea. Construction started on new smelters in Venezuela, Dubai, and Japan.

Table 16.—Aluminum: World production [1] by country
(Thousand short tons)

Country [2]	1973	1974	1975 p
North America:			
Canada	1,038	1,125	e 1,006
Mexico	48	45	44
United States	4,529	4,903	3,879
South America:			
Brazil	123	125	138
Surinam	r 57	60	29
Venezuela	r 26	58	64
Europe:			
Austria	98	101	98
Czechoslovakia	r 53	55	55
France	396	434	422
Germany, East e	101	96	66
Germany, West	587	759	747
Greece	159	163	149
Hungary	75	76	77
Iceland	79	70	68
Italy	203	234	210
Netherlands	209	277	288
Norway	684	716	651
Poland [3]	r 112	112	114
Romania [4]	156	206	209
Spain	179	211	231
Sweden	90	91	e 84
Switzerland	94	96	88
U.S.S.R. e	1,500	1,580	1,650
United Kingdom	277	324	340
Yugoslavia	100	162	185
Africa:			
Cameroon	49	51	57
Egypt, Arab Republic of	--	--	6
Ghana	166	173	158
South Africa, Republic of	58	83	86
Asia:			
Bahrain	113	130	128
China, People's Republic of e	r 165	r 165	180
India	170	142	184
Iran	37	54	55
Japan [5]	r 1,209	1,233	1,117
Korea, Republic of	r 34	19	22
Taiwan	39	35	31
Oceania:			
Australia	228	242	236
New Zealand	r 128	122	121
Total	r 13,364	14,528	13,273

e Estimate. p Preliminary. r Revised.
[1] Output of primary unalloyed ingot unless otherwise specified.
[2] In addition to the countries listed, Turkey produced aluminum in 1973 and 1974, and may have had additional output in 1975, but production is unreported and information is inadequate to make reliable estimates of output levels.
[3] Includes secondary.
[4] Includes alloys.
[5] Includes superpurity aluminum as follows in short tons: 1973—6,526; 1974—6,206; 1975—3,274.

Table 17.—World producers of primary aluminum

(Thousand short tons)

Country, company, plant location	Capacity, yearend 1975	Ownership
NORTH AMERICA		
Canada:		Alcan Aluminium Ltd. 100%.
Alcan Smelters and Chemicals, Ltd.:		
Arvida, Quebec	454	
Beauharnois, Quebec	51	
Isle Maligne, Quebec	105	
Kitimat, British Columbia	295	
Shawinigan Falls, Quebec	95	
Total	1,000	
Canadian Reynolds Metals Co. Ltd.:		Reynolds Metals Co. 100%.
Baie Comeau, Quebec	175	
Total Canada	1,175	
Mexico:		
Alumínio SA de CV, Vera Cruz	50	Aluminum Company of America 44.3%; Intercontinental 25.7%; Mexican interests 16%; U.S. and foreign interests 14%.
United States (See table 3)	5,021	
Total North America	6,246	
SOUTH AMERICA		
Argentina:		
Aluar Alumínio Argentino SAIC (Aluar):		FATE 51%; Alcan Aluminium Ltd. 8%; Kaiser Aluminum and Chemical Corp. 8%; Pechiney Ugine Kuhlmann Group 8%; private interests 24%; Government 1%.
Puerto Madryn	40	
Brazil:		
Alcan Alumínio do Brasil S.A.:		Alcan Aluminium Ltd. 100%.
Saramenha, Ouro Prêto	35	
Alumínio do Brasil Nordeste, S. A.:		Do.
Aratü, Bahia	28	
Companhia Brasileira de Alumínio:		Industria Votorantim, Ltd. 80%; Government 20%.
Sorocaba, São Paulo	44	
Companhia Mineira de Alumínio-(Alcominas):		Aluminum Company of America 50%; Hanna Mining Co. 40%; private interest 10%.
Poços de Caldas, Minas Gerias	33	
Total Brazil	140	
Surinam:		
Suriname Aluminum Co. (Suralco):		Aluminum Company of America 100%.
Paranam	73	
Venezuela:		
Alumínio del Caroni S.A. (Alcasa):		Reynolds Metals Co. 50%; Government 50%.
Puerto Ordaz, Mantanzas	55	
Total South America	308	
EUROPE		
Austria:		
Salzburger Aluminium GmbH (SAG):		Swiss Aluminium Ltd. 100%.
Lend, Salzburg	18	
Vereinigte Metallwerke Ranshofen Berndorf AG (VMRB):		Government 100%.
Ranshofen, Braunau A Inn	89	
Total Austria	102	
Czechoslovakia:		
Ziar Aluminium Works:		Government 100%.
Ziar-on-Hron	72	
France:		
Pechiney Ugine Kuhlmann Group (PUK):		Self 100%.
Auzat, Ariége	33	
L'Argentiére, Haute-Alpes	42	
La Praz, Savoie	4	
La Saussaz, Savoie	13	
Lannemezan-Haute Pyrénées	63	
Noguères, Basses-Pyrénées	127	
Rioupéroux, Isère	26	
St. Jean de Maurienne, Savoie	83	

Table 17.—World producers of primary aluminum—Continued
(Thousand short tons)

Country, company, plant location	Capacity, yearend 1975	Ownership
EUROPE—Continued		
France—Continued		
Pechiney Ugine Kuhlmann Group—Continued		
Sabart, Ariége	26	
Venthon, Savoie	31	
Total France	448	
Germany, East:		
Electrochemisches Kombinat:		Government 100%.
Bitterfeld	55	
Lautawerk	33	
Total Germany, East	88	
Germany, West:		
Aluminium-Hütte Rheinfelden GmbH:		Swiss Aluminium Ltd. 99.85%.
Rheinfelden, Baden	69	
Gebrueder Giulini GmbH:		Self 100%.
Ludwigshafen	50	
Kaiser-Preussag Aluminium GmbH & Co.:		Kaiser Aluminum & Chemical Corp. 50%; Preussag AG 50%.
Voerde	71	
Leichtmetall GmbH:		Metallgesellschaft AG 50%; Swiss Aluminium Ltd. 50%.
Essen	143	
Hamburger Aluminium-Werke GmbH:		Reynolds Aluminium Deutschland, Inc. 33.4%; Vereinigte Aluminium-Werke GmbH 33.3%; Vereinigte Metallwerke Ranshofen Berndorf AG 33.3%.
Hamburg	110	
Vereinigte Aluminium-Werke A.G. (VAW):		Government 100%.
Elbewerk, Stade	72	
Erftwerke, Grevenbroich	41	
Innwerke, Toging	61	
Lippenwerke, Lunen	55	
Norf, Rheinwerke	160	
Total Germany, West	832	
Greece:		
Aluminium de Grèce S.A. (ADG) Distomon	160	Pechiney Ugine Kuhlmann Group 90%; Government 10%.
Hungary:		
Magyarsoviet Bauxite Ipar:		Government 100%.
Ajka	19	
Inota	33	
Tatabanya	17	
Total Hungary	69	
Iceland:		
Icelandic Aluminium Co. Ltd., Hafnarfjordur	84	Swiss Aluminium Ltd. 100%.
Italy:		
Alcan Alluminio Italiano S.p.A.:		Alcan Aluminium Ltd. 100%.
Borgo-Franco d'Ivrea	4	
Societá Mineraria Chimica Metallurgica per l'Industria Dell'Alluminio in Sardegna (Alsar):		Government 94%; Montecatini Edison S.p.A. 6%.
Porto Vesme	138	
Alumetal S.p.A.:		Do.
Bolzano	66	
Fusina	40	
Mori	26	
Alluminio Veneto (SAVA):		Swiss Aluminium Ltd. 50%; Government 50%.
Fusina	33	
Porto Marghera	33	
Total Italy	340	
Netherlands:		
Aluminium Delfzijl N.V. (Aldel):		Holland Aluminium N.V. 100%.
Delfzijl	106	

Table 17.—World producers of primary aluminum—Continued
(Thousand short tons)

Country, company, plant location	Capacity, yearend 1975	Ownership
EUROPE—Continued		
Netherlands—Continued		
Pechiney Nederland N.V.:		Pechiney Ugine Kuhlmann Group 85%; Hunter-Douglas N.V. 11%; Alcan Aluminium Ltd. 4%.
Vlissingen (Flushing)	187	
Total Netherlands	298	
Norway:		
A/S Årdal og Sunndal Verk (ASV):		Government 75%; Alcan Aluminium Ltd. 25%.
Årdal	167	
Høyanger	33	
Sunndalsora	130	
Det Norske Nitridaktieselskap A/S (DNN):		Government 100%.
Tysseldal	27	
Lista Aluminiumverk A/S (Elkem):		Aluminum Company of America 50%; Elkem-Spigerverket A/S 50%.
Lista	62	
Mosjøen Aluminiumverk A/S (Mosal):		Do.
Mosjøen	105	
Norsk Hydro A/S Karmøy Fabrikker (Alnor):		Self 100%.
Karmøy Island	132	
Søer-Norge Aluminium A/S (Soral):		Swiss Aluminium Ltd. 75%; Compadec 25%.
Husnes	77	
Total Norway	733	
Poland:		
Ministry of Heavy Industry:		Government 100%.
Konin Works	61	
Skawina Works	61	
Total Poland	122	
Romania:		Government 100%.
Slatina	132	
Spain:		
Alumínio de Galicia S.A.:		Pechiney Ugine Kuhlmann Group 66%; ENDASA 17%; Government 17%.
La Coruña	86	
Sabinanego, Huesca	15	
Empresa Nacional del Alumínio S.A. (ENDASA):		Government 50.5%; Alcan Aluminium Ltd. 25%; Banco de-Bilboa SA 15%; Spanish interests 9.5%.
Aviles	111	
Valladolid	26	
Total Spain	238	
Sweden:		
Gränges Aluminium AB:		Gränges AB 79%; Alcan Aluminium Ltd. 21%.
Kubikenborg, Sundsvall	95	
Switzerland:		
Swiss Aluminium Ltd. (Alusuisse):		Self 100%.
Chippis, Valais	40	
Steg, Valais	53	
Usine d'Aluminium Martigny, S.A.:		Self 100%.
Martigny	12	
Total Switzerland	105	
U.S.S.R.:		Government 100%.
Bogoslovsk (Krasnoturinsk) Sverdlovskaya Oblast, Urals	160	
Bratsk, Irkutskaya Oblast, Siberia	350	
Irkutsk (Shelekovo) Irkutskaya Oblast, Siberia	300	
Kamensk-Ural'skiy Sverdlovskaya Oblast, Urals	160	
Kanaker (Yerevan), Armenia	110	
Kandalaksha, Murmanskaya Oblast	60	
Krasnoyarsk, Krasnoyarskiy Kray, Siberia	250	
Nadvoitsy, Karelskaya, A.S.S.R	60	
Novokuznetsk (Stalinsk) Kemeroyskaya Oblast, Siberia	200	
Regar, Duschanbe, Tadzhikstan	60	
Sumgait (Kirovabad), Azerbaijan	110	

Table 17.—World producers of primary aluminum—Continued
(Thousand short tons)

Country, company, plant location	Capacity, yearend 1975	Ownership
EUROPE—Continued		
U.S.S.R.—Continued		
Volgograd (Stalingrad) Volgogradskaya Oblast	150	
Volkhov (Zvanka), Leningrad Oblast	60	
Zaporozhye (Dneprovsk) Zaporozhskaya Oblast, Ukraine	110	
Total U.S.S.R	2,140	
United Kingdom:		
Alcan (UK) Ltd.:		Alcan Aluminium Ltd. 100%.
Lynemouth, Northumberland	132	
Anglesey Aluminium Ltd.:		Kaiser Aluminum & Chemical Corp. 67%; Rio Tinto Zinc Corp. Ltd. 33%.
Holyhead, New Wales, Scotland	112	
The British Aluminium Co., Ltd. (BACO):		Tube Investments Ltd. 49%; Reynolds Metals Co. 48%.
Invergordon, Scotland	112	
Kinlochleven, Scotland	11	
Lochaber (Fort William), Scotland	32	
Total United Kingdom	399	
Yugoslavia:		
Kombinat Aluminijuma Titograd:		Montenegro State Industry 100%.
Titograd, Montenegro	61	
Tovarna Glinice in Aluminija Boris Kidric:		Slovenia State Industry 100%.
Kidricevo, Slovenia	77	
Tvornica Lakih Metala Boris Kidric:		Dalmatia State Industry 100%.
Boris Kidric, Sibenik	83	
Total Yugoslavia	221	
Total Europe	6,673	
AFRICA		
Cameroon:		
Compagnie Camerounaise de l'Aluminum Pechiney Ugine (Alucam):		Pechiney Ugine Kuhlmann Group 60%; Cobeal 10%; Comal Cie. 30%.
Edea	61	
Ghana:		
Volta Aluminium Co. Ltd. (Valco):		Kaiser Aluminum & Chemical Corp. 90%; Reynolds Metals Co. 10%.
Tema	169	
South Africa, Republic of:		
Alusaf (Pty.) Ltd.:		Industrial Development Corp. (Government) and private South African interests 78%; Swiss Aluminium Ltd. 22%.
Richards Bay	88	
United Arab Republic: Nag Hamadi	110	Government 100%.
Total Africa	428	
ASIA		
Bahrain: Aluminium Bahrain Ltd. (ALBA)	132	Kaiser Aluminum & Chemical Corp. and British Metals 17% each; Western Metals 8.5%; Bretton Investments 5.1%; Bahrain Government 52.4%.
China, People's Republic of:		Government 100%.
Fushun, Kiaoning	110	
Changchun, Chilin; Changsha, Hunan; Hefei, Anhwei; Hunan, Hunan; Jiaozuo, Honan; Lanchow, Kansu; Taiyuan, Shansi; Tsingtao, Shantung; Wuhan, Hupei	160	
Total China, People's Republic of	270	
India:		
Aluminium Corp. of India Ltd. (Alucoin):		Self 100%.
Asansol, West Bengal	10	
Bharat Aluminium Co. (Balco):		State Government 100%.
Korba, Madhya Pradesh	28	
Hindustan Aluminium Corp. Ltd. (Hindalco):		Kaiser Aluminum & Chemical Corp. 27%; Birla and Indian interests 73%.
Renukoot, Uttar Pradesh	105	

Table 17.—World producers of primary aluminum—Continued
(Thousand short tons)

Country, company, plant location	Capacity, yearend 1975	Ownership
ASIA—Continued		
India—Continued		
Indian Aluminium Co. Ltd. (Indal):		Alcan Aluminium Ltd. 55%; Indian interests 45%.
Belgaum, Bombay	69	
Alupuram, Kerala	23	
Hirakud, Orissa	26	
Madras Aluminium Co. Ltd. (Malco):		Montecatini Edison S.p.A. 27%; Madras State Government 73%.
Mettur, Madras	28	
Total India	289	
Iran:		
Iranian Aluminium Co. (IRALCO), Arak	55	Iranian Government 82.5%; Reynolds Metals Co. 12.5%; Pakistani Government 5%.
Japan:		
Mitsubishi Chemical Industries Ltd.:		Self 100%.
Naoestu	176	
Sakaide	102	
Mitsui Aluminium Co. Ltd.:		Self 100%.
Omuta	131	
Nippon Light Metal Co., Ltd. (NLM):		Alcan Aluminium Ltd. 50%; Japanese interests 50%.
Kambara	118	
Hokkaido (Tomakomai)	136	
Niigata	160	
Showa Denko Chiba, Chiba	176	Showa Denko K.K. 100%.
Showa Denko K.K.:		Self 100%.
Kitakata	31	
Omachi	46	
Sumitomo Chemical Co., Ltd.:		Self 100%.
Isoura	88	
Nagoya	60	
Toyama	208	
Sumitomo Toyo Aluminium Smelting Co.:		Sumitomo Chemical Co., Ltd. 100%.
Shikoku, Toyo	60	
Total Japan	1,492	
Korea, Republic of:		
Aluminum of Korea Ltd. (Koralu):		Korean Development Bank 50%; Pechiney Ugine Kuhlmann Group 50%.
Ulsan	20	
Taiwan:		
Taiwan Aluminium Corp. (Talco):		Government 100%.
Kaohsiung, Takao	42	
Turkey:		
Etibank:		Government 100%.
Seydisehir	66	
Total Asia	2,366	
OCEANIA		
Australia:		
Alcan Australia Ltd.:		Alcan Aluminium Ltd. 70.5%; other interests 29.5%.
Kurri-Kurri, New South Wales	50	
Alcoa of Australia Ltd.:		Aluminum Company of America 51%; Australian interests 49%.
Point Henry, Victoria	99	
Comalco Ltd.:		Kaiser Aluminum & Chemical Corp. 45%; Conzinc Rio Tinto of Australia Ltd. 45%; other interests 10%.
Bell Bay, Tasmania	105	
Total Australia	254	
New Zealand:		
New Zealand Aluminium Smelters Ltd.:		Comalco Ltd. 50%; Sumitomo Chemical Co., Ltd. 25%; Showa Denko K.K. 25%.
Bluff	123	
Total Oceania	377	
Total World	16,398	

Abu Dhabi.—Nissho Iwai Co. Ltd. and British Smelter Construction Ltd. announced a feasibility study for a 165,000- to 200,000-ton-per-year smelter. Plans reportedly called for initial production of 28,000 tons by 1979.

Australia.—Comalco Ltd. continued plans for an alumina reduction plant on Boyne Island. Startup of the 110,000-ton-per-year potline was expected by 1980. Mitsubishi Chemical Industries Ltd. and Kobe Steel Ltd. reportedly would be partners in the project. Comalco postponed the startup of a 20,000-ton-per-year expansion at its Bell Bay smelter until 1977.

Bahrain.—Aluminium Bahrain Ltd. (ALBA) announced plans to add another potline by 1979. The expansion would bring the rated capacity to 156,000 tons per year. Alumina for the plant was supplied by Alcoa of Australia Ltd. from its Kwinana refinery. ALBA also announced plans to expand its production of extrusion billet from 14,000 tons per year to 33,000 tons per year.

Brazil.—Negotiations continued on the Aluminío do Brasil (Albras) alumina-aluminum project near Belem. The state-owned Companhia Vale do Rio Doce (CVRD) agreed to finance the $1.4 billion hydroelectric project on the Tocantins River. Electrobras reportedly signed a contract with Camargo Corea S.A. for the construction of the power facility, which was scheduled to be completed by late 1981.

The Light Metal Smelters Association (LMSA), the Japanese group that includes Nippon Light Metal Co., Ltd., Showa Denko K.K., Sumitomo Chemical Co. Ltd., Mitsubishi Chemical Co. Ltd., and Mitsui Aluminium Co. Ltd., requested that the project be scaled down to include a 353,000-ton-per-year smelter and a 716,000-ton-per-year alumina refinery. The alumina-aluminum complex, owned 51% by CVRD and 49% by LMSA, would be supplied with bauxite from Trombetas.

CVRD also announced that it was looking for partners for a smelter to be located on Sepetiba Bay near Rio de Janeiro. Tentative plans called for two 44,000-ton-per-year potlines to come onstream in 1979 and 1980, respectively. The plant, which would serve as a model for the Albras project, would use imported alumina.

Mitsubishi Chemical and Swiss Aluminium Ltd. (Alusuisse) announced a feasibility study for a $400 million smelter in the Amazon region. Work on the 220,000-ton-per-year smelter was scheduled to start in 1977 with no announced startup date. Alumina would initially be supplied by Alusuisse foreign plants and later from Mitsubishi bauxite reserves in Brazil. Mitsubishi would take half of the plant's metal production.

Sumitomo Chemical announced a target date of 1977 for the startup of a 170,000-ton-per-year smelter in Recife. Cost of the plant was estimated at $200 million.

Companhia Brasileira de Alumínio (CBA) received a loan from the Brazilian National Economic Development Bank to expand the Sorocaba aluminum smelter to 120,000 tons per year by adding a third potline. Expansion began in 1975 to raise the capacity of the plant to 88,000 tons per year. CBA recently acquired a hydroelectric plant on the Sorocaba River which would supply the additional power requirements of the expansions.

The Alumínio do Brasil Nordeste S.A., 28,000-ton-per-year smelter at Aratu was completed.

Canada.—The Government of Quebec and National-Southwire Aluminum Co. announced plans for a 125,000-ton-per-year smelter in St. Augustin, Quebec. The plant would be constructed and owned by Quebec General Investment Corp. National Southwire would supply technology and would receive 30% of the output. The $450 million complex was scheduled to come onstream in 1978 and would include fabricating facilities.

The Aluminum Company of Canada, Ltd. (Alcan) formed a new subsidiary, Alcan Smelters and Chemicals, Ltd., to consolidate all smelting, chemical, and related activities.

Alcan operated at 79% of its 1-million-ton-per-year rated capacity during most of 1975. Labor disputes at the Kitimat, British Columbia, and Arvida, Quebec, smelters were reported. Alcan signed a 20-year technical exchange agreement with Nippon Light Metal Co. Ltd., which is owned 50% by Alcan.

China, People's Republic of.—The Chinese reportedly bought up to 200,000 tons of primary aluminum from western producers. Kaiser Aluminum & Chemical Corp. sold 50,000 tons, to be delivered primarily from its Tacoma, Wash., and Chalmette, La., smelters. Howmet Corp., a subsidiary of PUK, reportedly sold 20,000 tons to the Chinese. Other companies that sold primary ingot to the Chinese included Alcan and A/S Årdal og Sunndal Verk (ASV).

Dubai.—Construction on a 135,000-ton-per-year aluminum smelter at Jebel Ali started. Completion of the $310 million facility was scheduled for 1978, with full production expected in 1981. The infrastructure would allow for an additional 45,000-ton-per-year expansion. The plant, which would probably use diesel oil to generate electricity, was to be owned 80% by the Dubai Government, 10% by Southwire Co. which would supply the technology, and 10% by British Smelter Construction which conducted the feasibility study.

France.—PUK announced a $25 million modernization program for its Lannemezan smelter. The modernization, which would increase the 63,000-ton-per-year capacity by 1% and reduce fluoride emissions by 50%, was scheduled to start in 1976.

PUK operated its smelters at 6% below rated capacity during 1975. Stocks during that period more than doubled, from 60,000 tons at the end of 1974 to 130,000 tons at the end of 1975.

Germany, Federal Republic of.—Kaiser acquired the remaining 50% interest in the Kaiser-Preussag A.G. (Kapal) fabricating facilities. Kaiser announced plans to take the full production of the primary aluminum smelter at Voerde and reportedly held an option to acquire the remaining interest in that operation.

Hamburger Aluminium-Werke GmbH operated the 110,000-ton-per-year smelter in Hamburg under a 22½ year installment agreement whereby Reynolds Aluminium Deutschland, Inc., Vereinigte Aluminum-Werke AG, and Vereinigte Metallwerke Ranshofen-Berndorf AG would eventually own the plant.

Leichtmetall GmbH sought to sell its 50% interest in the Essen smelter. Gebrueder Giulini GmbH announced that it was looking for partners in the operation of its 50,000-ton-per-year smelter at Ludwigshafen.

Ghana.—The fifth potline at the Volta Aluminium Co. Ltd. plant at Tema was under construction at an estimated $65 million cost. Upon completion in 1976, the smelter would have a rated capacity of 220,000 tons per year. The Volta River Authority agreed to supply additional power.

Greece.—Agreement was reached between Aluminium de Grece SA, which operated a primary smelter at Distomon, and the Grecian Electricity Co. (DEI) to increase the price for power to 4.375 mills per kilowatt-hour for the original structure of the smelter facility and to 13 mills per kilowatt-hour for power supplied for expansions.

India.—The first stage of the Bharat Aluminium Co. smelter at Korba, Madhya Pradesh, came onstream with an initial capacity of 28,000 tons per year. The plant, which utilized Soderberg cells, was built with Soviet and Hungarian assistance and was scheduled to reach a capacity of 110,000 tons per year by 1980.

A feasibility study was underway for a 22,000-ton-per-year aluminum smelter in the Kolhapur district of Maharashtra. The facility, which would draw on bauxite deposits in the district, was projected to reach a capacity of 110,000 tons per year.

Discussions between the Central Indian Government and Andhra Pradesh and Orissa State Governments were underway for an alumina-aluminum complex at Vishakapatnam. Bauxite from Orissa and Galikonda would be used.

Indonesia.—Nippon Asahan Aluminum Co. was formed to build a 225,000-ton-per-year aluminum smelter in Northern Sumatra. The company was comprised of the Overseas Economic Cooperation Fund, a Japanese governmental agency, with a 50% interest, and 12 Japanese firms including Nippon Light Metal Co. Ltd., Sumitomo Chemical Co., Ltd., Mitsubishi Chemical Industries Ltd., Showa Denko K.K., and Mitsui Aluminum Co. Ltd. The P. T. Indonesian Asahan Co., owned 10% by the Indonesian Government and 90% by Nippon Asahan Aluminum Co., was scheduled to be formed in 1976 to construct the smelter and hydroelectric facility. The first 75,000-ton-per-year stage of the aluminum plant was scheduled to come onstream in 1981, with full capacity expected in 1983.

Iran.—Plans were announced to expand the Iranian Aluminium Co. (IRALCO) smelter at Arak from 55,000 tons per year to 132,000 tons per year. IRALCO also announced that a feasibility study was underway in conjunction with Alumax, Inc., for a second smelter in Iran.

Italy.—The primary aluminum smelters operated by the State corporation Ente Participazione Finanziamento Industria Manifattura (EFIM) functioned at about 60% of their rated capacity of 303,000 tons per year owing to decreased domestic demand.

Japan.—Sumitomo Toyo Aluminium Smelting Co. began operations at its Shikoku, Toyo, plant. The capacity of the plant, which used the Sumitomo Soderberg cells, was 60,000 tons per year, and plans called for expansion to 100,000 tons per year by 1976. The firm was a subsidiary of Sumitomo Chemical Co., Ltd.

Sumikei Aluminium Industries, a subsidiary of Sumitomo Light Metal Industries Ltd., announced that it was going ahead with construction of a 90,000-ton-per-year smelter at Sagata. Initial production was believed to be possible by late 1976. Alumina for the plant, which would be doubled in capacity by 1980, would be supplied by Australian refineries.

Mitsui Aluminium Co. Ltd. started up the first 40,000-ton-per-year potline of its expansion at the Miike, Omuta, smelter. A second 43,000-ton-per-year line was under construction.

Construction on the Furukawa Aluminum Co. Ltd. smelter was scheduled to start by mid-1976 with startup scheduled for 1979. The 77,000-ton-per-year facility would use alumina supplied by Alcoa of Australia Ltd. Alcoa owned 33% of the company, and C. Itoh & Co. Ltd. reportedly acquired a 12.5% share in Furukawa. C. Itoh had sole trading rights in Japan for alumina produced by Alcoa of Australia Ltd.

Construction on the 100,000-ton-per-year expansion of the Showa Denko K.K. plant at Chiba continued, and one 50,000-ton-per-year potline was completed. Startup of the potline was delayed until 1976. Showa Denko established a new subsidiary company, Showa Denko Chiba, to operate the facility.

Mitsubishi Chemical Industries Ltd. announced that 16 of the 144 cells under construction at its Sakaide smelter were operational. The smelter capacity was to have been expanded to 110,000 tons per year by the end of 1975, but expansion was delayed due to decreased demand.

Korea, Republic of.—PUK announced plans to double the capacity of the Aluminium of Korea Ltd. smelter at Ulsan to 40,000 tons per year by 1977. A second expansion was scheduled to raise capacity to 79,000 tons per year by 1979.

A second smelter at Ulsan was under consideration by the South Korean Government. Startup of the 110,000-ton-per-year smelter was scheduled for 1978.

Mexico.—Plans continued for a second smelter with a capacity of 120,000 tons per year to be constructed at Vera Cruz. A 900,000-ton-per-year alumina refinery to be built in Jamaica would supply the required raw materials. Planned ownership of the $400 to $500 million complex was Mexico 51%, Jamaica 29%, and Reynolds 20%.

Netherlands.—Alcan purchased 24.9% of Hunter Douglas, N.V. Hunter Douglas operated a primary smelter at Vlissingen in conjunction with Pechiney. Plans were announced to expand the smelter to 280,000 tons per year at an estimated cost of $114 million. Construction was scheduled to start in 1977.

New Zealand.—New Zealand Aluminium Smelters Ltd. announced plans to commission the 42,000-ton-per-year expansion of the Bluff smelter in 1976. The $48 million project would raise the capacity of the plant to 165,000 tons per year.

Nigeria.—Construction of a primary aluminum smelter was under consideration. Alumina from Jamaica would be used.

Norway.—The Norwegian Government bought Alcan and British Aluminium Co., Ltd. shares in Det Norske Nitridaktieselskap A/S (DNN) for $35 million. DNN operated a 27,000-ton-per-year smelter at Tysseldal.

ASV announced plans to modernize smelters at Årdal, Høyanger, and Sunndalsora. The program would raise ASV capacity to 385,000 tons per year by 1985.

Startup of the third potline at the Lista Aluminiumverk A/S smelter was postponed until 1976. The 26,000-ton-per-year expansion would raise the plant capacity to 88,000 tons per year.

Norsk Hydro purchased primary aluminum smelting technology from Sumitomo Chemical for use at its Karmøy smelter. The process involved 40,000-ampere Soderberg cells and reportedly used 20% less energy than present cells at Karmøy.

Paraguay.—Reynolds Metals Co. announced a feasibility study for a 310,000-ton-per-year aluminum smelter expected to cost about $700 million. Power for the facility would be supplied by a hydroelectric plant already under construction.

Philippines.—Reynolds undertook a feasibility study for a 140,000-ton-per-year aluminum smelter and a 755,000-kilowatt hydroelectric plant on Mindanao Island. Reynolds owned 51% of Reynolds Philippine Corp., a fabricating company which produced sheet, foil, and extrusions.

Saudi Arabia.—The Government-owned company Petromin announced plans to construct a 230,000-ton-per-year smelter within the next 5 years. Sumitomo would provide the technology.

Spain.—Ground clearing started for the Aluminio Español alumina-aluminum complex at San Cipriano, Lugo. The plans included a 175,000-ton-per-year smelter and an 880,000-ton-per-year refinery to come onstream in 1977 and 1978 respectively. Bauxite for the refinery would be imported from Guinea.

Alumínio de Galicia S.A. (Alugasa) announced plans to expand its 15,000-ton-per-year smelter at Sabinanego with technical assistance by Pechiney. Plans also were announced to expand the La Coruña smelter to 106,000 tons per year by 1978.

Sweden.—Gränges Aluminium AB announced plans to expand the Sundsvall plant from 95,000 tons per year to 145,000 tons per year.

Taiwan.—The Taiwan Aluminium Corp. 35,000-ton-per-year expansion at its Kaohsiung smelter was scheduled to begin operations in 1976. Announced expansion plans would raise capacity to 99,000 tons per year by 1979.

U.S.S.R.—The new Regar smelter in the Republic of Tadzhikstan reportedly began trial operation. It was also reported that equipment problems could delay the production level from reaching designed capacity until 1977. Power was supplied by the Nurek hydroelectric project.

Negotiations continued with Pechiney to construct a primary smelter and an alumina refinery in Siberia. Kaiser also sent a delegation to the Soviet Union to discuss possible smelter construction contracts.

United Kingdom.—Kaiser increased its share in Anglesey Aluminium Ltd. to 66.7%, and Rio Tinto-Zinc Corp. Ltd. decreased its share to 33.3%. British Insulated Calender Cables was no longer a shareholder in the company.

Venezuela.—Alumínio del Caroni S.A. (Alcasa) obtained a $70 million loan from Fondo Inversiones for the 70,000-ton-per-year expansion of its Ciudad Guyana smelter. The smelter capacity was scheduled to be increased to 125,000 tons per year by 1978. The remainder of the estimated $200 million expansion cost would be financed by the private sector.

Land clearing for the New Venalum 77,000-ton-per-year smelter began, and startup was rescheduled for 1978. Ownership of the facility consisted of Corporacion Venezolana de Guyana (CVG) 80%, Showa Denko K.K. 7%, Mitsubishi 4%, Kobe Steel 4%, Sumitomo 4%, and Marubeni 1%. Plans called for eventual expansion to 280,000 tons per year.

Zaire.—Alusuisse and the Government of Zaire announced plans for a 175,000 to 220,000-ton-per-year smelter to be located near Banana on the Congo estuary. Bauxite for the facility would be supplied by reserves to be developed in the Inga-Sumbia region. Power was to be supplied by the Inga hydroelectric facility.

TECHNOLOGY

Battelle Columbus Laboratories, under contract to the Bureau of Mines, estimated the energy rquirements for all phases of the aluminum production process.[3] Energy values of raw materials, transportation, byproducts, and waste products were included in the average energy use for the United States of 243.9 X 10^6 British thermal units (Btu) per ton of aluminum. Energy inputs for the transportation of imported bauxite were based on 1973 statistics with the imports from each of the exporting countries distributed proportionately on a ton-per-mile basis.

Energy required for bauxite mining, transportation, crushing, washing, screening, and drying was estimated at 4.79 X 10^6 Btu per ton of aluminum. The Bayer process was estimated to use 42.6 X 10^6 Btu per ton of aluminum. Production of carbon anodes required 20.86 X 10^6 Btu per ton of aluminum, and the manu-

[3] Battelle Columbus Laboratories. Energy Use Patterns in Metallurgical and Nonmetallic Mineral Processing (Phase 4—Energy Data and Flowsheets, High-Priority Commodities). Battelle Columbus Laboratories (Columbus, Ohio), June 27, 1975, 172 pp., available from National Technical Information Service, Springfield, Va., PB 245 759.

facturing process for carbon cathodes required 1.21×10^6 Btu per ton of aluminum. The aluminum reduction process required 174.47×10^6 Btu per ton of aluminum, on the assumption that the electricity used was thermally generated, using 10,500 Btu per kilowatt-hour. Since about 40% of the electricity used by the aluminum industry was based on hydropower, total actual use was about 204×10^6 Btu per ton of aluminum.

Energy requirements of 0.81×10^6 Btu per ton of aluminum for pollution controls were also included in the total. Total energy use in this area included 0.59×10^6 Btu per ton of aluminum for control of the emissions from reduction cells and carbon bake furnaces, 0.04×10^6 Btu for dust control in the Bayer plant calciner, and 0.18×10^6 Btu for miscellaneous operations within the production process. Battelle projected the total industrywide energy consumption for pollution controls by 1980 at 1.90×10^6 Btu per ton of aluminum, with control of emissions from reduction cells and the carbon plant accounting for 1.77×10^6 Btu per ton of aluminum.

The International Primary Aluminium Institute released data on capital and operating costs to achieve various levels of control of fluorine emissions from reduction cells.[4] The data on emission and costs were based on answers to a detailed questionnaire sent to member companies.

Sumitomo Toyo Aluminium Smelting Co. began operation of an improved procedure for Soderberg cells.[5] The procedure, which was used in all of Sumitomo's Soderberg processing plants in Japan, reportedly reduced power consumption by 15% to 20%, nearly doubled cell life, and cut emissions of hydrocarbon smoke by 50% and fluoride gases by 40%. The Sumitomo cell minimized voltage fluctuations by altering the heat balance through the cathode, reduced fluoride emissions by improving the crust-breaking operation, and cut emissions of hydrocarbons from the self-baking anodes by changing the design and composition of the anode.

A report described methods for improving energy utilization of aluminum-melting furnaces by maintaining an appropriate fuel-to-air ratio, by reducing the infiltration of cold air into the furnace, and by careful planning of charging and production cycles.[6] Methods for distributing the flame and placing the burner in the furnace for maximum efficiency also were described, as were the energy savings made possible by recirculating partially burned exhaust gases.

The Environmental Protection Agency finalized pollution control requirements for aluminum smelters under construction or being modified as of October 23, 1974, effective January 26, 1976.[7] The regulations required removal of 95% of the fluoride emissions before air is released from the stacks. Emissions from prebake plants were limited to 1.9 pounds of fluoride per ton of aluminum and from Soderberg plants to 2.0 pounds per ton. Opacity of the emissions was limited to 10% at both types of plants.

Fluorine emissions from anode bake plants were limited to 0.1 pound per ton of anodes produced. Opacity of the emissions from bake plants was limited to 20%. Emission control guidelines for existing aluminum reduction and anode bake plants were under study.

The recovery and recycling of fluorides from the alumina reduction process in relation to the operation of the electrolytic cell was studied.[8] Surplus cryolite was believed to be formed when the Na_2O content of the alumina used in the cell exceeded 0.8%. Since recovery of fluorine from pot gas emissions by dry absorption forms significant quantities of aluminum fluoride, it was postulated that recycling cryolite from used potlinings would help to maintain an appropriate balance of electrolyte constituents.

Relatively pollution-free processes to reduce the magnesium content of molten aluminum to less than 0.1% by halogenation were discussed.[9] It was stated that the process by which the magnesium is reacted

[4] International Primary Aluminium Institute Environmental Committee Report. Fluoride Emissions Control: Costs for New Aluminum Reduction Plants. April 1975, 28 pp.

[5] Chemical and Engineering News. Aluminum Cell Modifications Cut Energy Use. V. 53, No. 31, Aug. 4, 1975, pp. 19–20.

[6] Stephens, W. E. Improving Energy Utilization of Aluminum Melting Furnaces. Proc. Ann. Meeting, Light Met. Soc., AIME, The Dalles, Oreg., February 1975, pp. 51–58.

[7] U.S. Environmental Protection Agency. Performance Standards for New Stationary Sources. Primary Aluminum Industry, Part 3. V. 41, No. 17, Federal Register, Jan. 26, 1976, pp. 3826–3830.

[8] Frankenfeldt, R. E. Environmental Conservation Through Recycling of Materials Used in the Electrolysis Process. Aluminum, v. 51, November 1975, pp. 22–27.

[9] Mangalick, M. C. Demagging in the Secondary Aluminum Industry. J. Metals, v. 27, No. 6, June 1975, pp. 6–10.

with a halogen, such as chlorine, to produce magnesium chloride, which floats to the surface and can be removed, could be 100% efficient if physical contact of the reactants is prolonged to provide time to react with the magnesium and if the aluminum chloride formed in the process is contained within the metal before it reaches the bath surface. Several processes to accomplish these objectives were discussed.

A magnetic device, which could be used to separate 150 pounds per hour of aluminum from 20 tons of raw municipal refuse, began operation at the National Center For Resource Recovery in Washington, D.C. The magnet, which operates on the eddy current principle, repels aluminum scrap by utilizing the electrical polarity induced in the aluminum by a magnetic field. Aluminum scrap recovery from municipal waste was under study at Franklin, Ohio, where a new system, also based on the eddy current principle, could separate 60 to 250 pounds of aluminum per hour.[10] Similar studies were underway in Baltimore County, Md., where continuous separation is based on Bureau of Mines technology.[11]

An updated economic evaluation of the Bureau of Mines process for separating aluminum and other materials from incinerator residues was published.[12]

The separation of metals and other materials in an automobile for cryogenic fragmentation was under development by George et Cie. of Belgium.[13] In this process, called the Inchscrap process, up to 30 tons of automobiles are recycled per hour. The cars are compressed into rectangular bales, and liquid nitrogen, 196° C below zero, is used to embrittle the materials, which are then fed into a fragmentizer which shatters steel and other metal components and rubber and plastic materials into gravel-size pieces. The aluminum and other components are separated from the fragmentized automobile by conventional classification techniques based on size, density, and magnetic properties.

Previous Bureau of Mines investigations demonstrated the usefulness of low temperatures to improve grinding results and subsequent separation of mixed wastes.[14]

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[10] Haflich, F. Aluminum Separator System Under Test in Ohio Waste Plant. Am. Metal Market, v. 82, No. 34, Feb. 19, 1975, p. 22.

[11] U.S. Bureau of Mines. Recycling Resources From Urban Refuse. Current Trends in Metallurgy, June and July 1975, pp. 35–36.

[12] Henn, J. J. Updated Cost Evaluation of a Metal and Mineral Recovery Process for Treating Municipal Incinerator Residues. BuMines IC 8691, 1975, 44 pp.

[13] Pearce, P. Cryogenic Scrap Fragmentation. Metal Bull. Monthly, No. 58, October 1975, pp. 51–53.

[14] Valdez, E. G., K. C. Dean, and W. L. Wilson. Use of Cryogens To Reclaim Nonferrous Scrap Metals. BuMines RI 7716, 1973, 13 pp.

Antimony

By John A. Rathjen [1]

With the exception of domestic mine production, all phases of the U.S. antimony industry during 1975 operated at lower levels than in 1974. A drop in consumption to 12,987 tons, the lowest recorded usage since 1961, was attributed generally to adverse economic conditions. Smelter and secondary metal production along with imports and exports also declined, but industry stocks reached a record high in 1975.

Domestic mine production rose for the third consecutive year. The slow but steady recovery of mine production was due to rehabilitation of the Sunshine mine in Idaho, which was damaged by a serious fire in 1972, and to increased output at the Babbitt mine in Montana.

Depressed economic conditions were reflected in the New York price quotation, which averaged 204.49 cents per pound during the first quarter, but dropped rapidly to 160.00 cents per pound in the second quarter, where it remained for the balance of the year.

Table 1.—Salient antimony statistics
(Short tons)

	1971	1972	1973	1974	1975
United States:					
Production:					
Primary:					
Mine	1,025	489	545	661	886
Smelter [1]	11,374	13,344	17,206	16,657	12,189
Secondary	20,917	22,428	24,062	23,570	17,964
Exports of ore, metal and alloys	1,023	121	515	871	340
Imports, general (antimony content)	13,595	23,743	21,265	22,119	18,706
Consumption [1]	13,707	16,124	20,613	18,041	12,987
Price: New York, average cents per pound	71.18	59.00	68.50	181.76	176.58
World: Production	70,653	73,986	r 76,920	r 79,232	74,802

r Revised.
[1] Includes primary antimony content of antimonial lead produced at primary lead refineries.

DOMESTIC PRODUCTION

MINE PRODUCTION

Total domestic mine production of antimony in 1975 rose to 886 tons, an increase of 34% over the 1974 output. All antimony mined was from Idaho and Montana; properties in Alaska, California, and Nevada remained inactive throughout the year. The Sunshine mine, operated by the Sunshine Mining Co. in the Coeur d'Alene district of Idaho, was the largest producer with 613 tons of antimony produced in ore during 1975. This output represents a 78% increase from the low level of production in 1972 when operations were curtailed by a serious mine fire. The principal antimony ore mineral mined in this district is tetrahedrite, a complex silver-copper-antimony sulfide.

The U.S. Antimony Corp. at Thompson Falls, Mont., continued its expansion program at the Babbitt mine-mill-smelter complex. Mine output during 1975 was 273 tons of antimony in ore, an increase of 104 tons above the 1974 production. The principal antimony mineral from the Babbitt

[1] Mineral specialist, Division of Nonferrous Metals.

mine is stibnite, the most common of the antimony ore minerals.

Antimony recovered as a byproduct in smelting of domestic lead concentrates dropped to 268 tons in 1975, down from 658 tons recovered in 1974. This decrease in production of antimonial lead from domestic ores was attributed to a changeover in basic smelter feed.

Table 2.—Antimony mine production and shipments in the United States
(Short tons)

Year	Antimony concentrate	Antimony	
		Produced	Shipped
1971	4,721	1,025	1,073
1972	2,072	489	547
1973	2,468	545	494
1974	3,217	661	593
1975	4,505	886	966

SMELTER PRODUCTION

Primary.—Overall smelter production of primary antimony products in 1975 was 12,189 tons, 27% less than in 1974. A small gain of 7% in production of primary antimony metal was exceeded by significant losses in output of oxide, sulfide, residues, and byproduct metal. The sharpest decrease was in production of antimony oxide, which dropped to 7,890 tons, a loss of 24% from the comparable output in 1974. Most of this decline was due to lower demand, although imports of oxide from the Republic of South Africa displaced some domestic production.

Antimony metal was produced by NL Industries, Inc., at its Laredo, Tex., smelter, Sunshine Mining Co., at its electrolytic operation in Kellogg, Idaho, U.S. Antimony Corp. at its smelter in Thompson Falls, Mont., and Intermountain Smelting Corp. at Salt Lake City, Utah. The major producers of antimony oxide were ASARCO Inc. at Perth Amboy, N. J., Chemetron Corp. at Cuyahoga Heights, Ohio, Harshaw Chemical Co. at Gloucester City, N. J., and M & T Chemicals Inc. at Baltimore, Md.

Table 3.—Primary antimony produced in the United States
(Short tons, antimony content)

Year	Class of material produced					Total
	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	
1971	3,816	6,272	18	136	1,132	11,374
1972	3,837	8,343	232	201	731	13,344
1973	2,859	11,273	92	1,839	1,143	17,206
1974	3,030	10,445	54	2,066	1,062	16,657
1975	3,254	7,890	--	595	450	12,189

Table 4.—Byproduct antimonial lead produced at primary lead refineries in the United States
(Short tons)

Year	Gross weight	Antimony content				
		From domestic ores [1]	From foreign ores [2]	From scrap	Total	
					Quantity	Percent
1971	19,686	828	304	59	1,191	6.0
1972	15,051	516	215	319	1,050	7.0
1973	15,455	731	412	24	1,167	7.6
1974	12,513	658	404	35	1,097	8.8
1975	6,029	268	182	117	567	9.4

[1] Includes primary residues and a small quantity of antimony ore.
[2] Includes foreign base bullion and small quantities of foreign antimony ore.

Secondary.—Scrap lead recycled at primary and secondary lead plants in 1975 produced 17,964 tons of antimony as a coproduct. This represents a decline of 5,600 tons from the level of 1974 and reflects the slow rate of secondary activity during the year. Most of the antimony was generated from battery scrap (66%), with the balance coming from various materials including drosses, residues, type metal, old bearings, and other items. Antimonial lead recovered through this process is alloyed to specific assay requirements and resold directly to consumers. In the future, as new battery systems are developed, it is believed that more antimony will be produced in the form of pure metal.

Table 5.—Secondary antimony produced in the United States, by kind of scrap and form of recovery
(Short tons, antimony content)

Kind of scrap	1974	1975
New scrap:		
Lead-base	2,950	1,905
Tin-base	43	39
Total	2,993	1,944
Old scrap:		
Lead-base	20,561	16,007
Tin-base	16	13
Total	20,577	16,020
Grand total	23,570	17,964

Form of recovery	1974	1975
In antimonial lead [1]	18,963	14,768
In other lead alloys	4,597	3,187
In tin-base alloys	10	9
Total	23,570	17,964
Value (millions)	$85.7	$63.4

[1] Includes 35 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1974 and 117 tons in 1975.

CONSUMPTION AND USES

Domestic consumption of antimony in 1975 dropped to 12,987 tons, a decline of 28% from the 1974 level. All of the consuming categories were down with the largest drop in use for metal products which totaled 5,647 tons, 2,782 tons less than in 1974. Use of antimony in nonmetal products and flameproofing chemicals combined was 7,340 tons, a decline of 24% from the corresponding total in 1974. Overall, the use of antimony for specific applications decreased in relative proportion to low demand. The one exception was consumption by the battery industry, which declined from 7,251 tons in 1974 to 4,568 tons in 1975. The reason for this drop in use was attributed partly to the production of maintenance-free automotive batteries that utilize a calcium-tin alloy as a substitute for antimony in the grid system.

Use of antimony trioxide in flame retardants did not grow as expected in 1975, as consumption declined approximately 13% to 3,799 tons. This decline was considerably less than the general downturn, however, and it is anticipated that future growth in this use category may offset projected losses in antimony used in the battery industry.

The various compounds of antimony such as sodium antimonate, antimony pentachloride, antimony pentasulfide, and others, continued to find application in the glass, ceramic, rubber, and paint industries.

Table 6.—Industrial consumption of primary antimony in the United States
(Short tons, antimony content)

Year	Class of material consumed						
	Ore and concentrate	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	Total
1971	387	5,080	6,944	28	136	1,132	13,707
1972	1,226	5,473	8,389	104	201	731	16,124
1973	582	5,824	10,970	255	1,839	1,143	20,613
1974	1,032	4,362	9,457	62	2,066	1,062	18,041
1975	369	4,229	7,311	33	595	450	12,987

Table 7.—Industrial consumption of primary antimony in the United States, by class of material produced

(Short tons, antimony content)

Product	1971	1972	1973	1974	1975
Metal products:					
Ammunition	67	64	122	121	239
Antimonial lead	5,430	6,149	8,027	7,251	4,568
Bearing metal and bearings	515	559	527	476	402
Cable covering	36	19	12	16	23
Castings	20	39	65	31	18
Collapsible tubes and foil	22	20	12	18	9
Sheet and pipe	74	108	97	69	60
Solder	178	177	191	205	133
Type metal	177	142	134	107	75
Other	102	105	104	135	120
Total	6,621	7,382	9,291	8,429	5,647
Nonmetal products:					
Ammunition primers	23	23	18	11	14
Fireworks	4	4	5	11	10
Ceramics and glass	1,840	1,695	1,917	1,384	989
Pigments	592	644	644	460	321
Plastics	1,810	2,391	2,920	1,431	1,091
Rubber products	525	587	693	664	458
Other	768	1,118	2,219	1,268	658
Total	5,562	6,462	8,416	5,229	3,541
Flame retardant: [1]					
Plastics	1,524	2,280	2,906	2,711	2,501
Pigments				172	92
Rubber				252	172
Adhesives				231	126
Textiles				980	748
Paper				37	160
Total	1,524	2,280	2,906	4,383	3,799
Grand total	13,707	16,124	20,613	18,041	12,987

[1] Flameproofing chemicals and compounds shown separately by use starting 1974.

STOCKS

Industry stocks of antimony continued to climb for the third consecutive year, reaching a record high of 14,957 tons at the end of 1975. Antimony contained in ores and concentrates, the largest gain, totaled 8,364 tons, an increase of 33% compared with the yearend 1974 level. Inventories of metal, oxide, residues and slags, and primary antimonial lead also increased from the 1974 level. The overall rise was due primarily to the decrease in demand during the year.

Table 8.—Industry stocks of primary antimony in the United States, December 31

(Short tons, antimony content)

Stocks	1971	1972	1973	1974	1975
Ore and concentrate	3,582	3,562	5,585	6,275	8,364
Metal	1,367	1,332	1,540	809	1,380
Oxide	2,697	3,179	2,074	3,732	3,886
Sulfide	22	182	31	35	32
Residues and slags	647	176	526	549	921
Antimonial lead [1]	322	191	322	294	374
Total	8,637	8,622	10,078	11,694	14,957

[1] Inventories from primary sources at primary lead refineries only.

PRICES

The general decline in demand in world markets during 1975 precipitated a downturn in prices for antimony products. The quoted sale price for RMM antimony metal, New York basis, was $2.25 per pound at the beginning of 1975. On January 20, the quotation was dropped to $1.99 per pound; May 19, to $1.75 per pound; and on June 1, the price was posted at $1.60 per pound, where it remained for the balance of the year. The price for foreign antimony metal, ex-dock New York, was quoted from a high of $2.00 to a low of $1.30 per pound. With the European free-market prices under parity during 1975, a discount situation prevailed. Antimony trioxide also declined in value during 1975, dropping in price from $2.16 per pound at the beginning of the year to $1.65 per pound at yearend. The quoted price for lump ore, on a 60% antimony basis, reflected reduced demand levels, and decreased from a range of $32 to $33 in January to a range of $17 to $18 per short ton unit c.i.f. in December.

Table 9.—Antimony price ranges in 1975

Type of antimony	Price per pound
Domestic metal [1]	$1.58–$2.23
Foreign metal [2]	1.30– 2.00
Antimony trioxide [3]	1.65– 2.16

[1] RMM brand, f.o.b., Laredo, Tex.
[2] Duty-paid delivery, New York.
[3] Quoted in Metals Week.

FOREIGN TRADE

Exports of antimony of all classes in 1975 declined to a total of 628 tons, a drop of 57% from the 1974 level. Antimony metal exports, in the form of pure metal, alloy, or scrap dropped to 340 tons in 1975 compared with 871 tons in 1974. Four countries received 80% of the total metal exports; the United Kingdom (28%), the Netherlands (26%), Canada (14%), and Italy (12%). The balance was distributed evenly among nine other countries. Exports of antimony oxide also declined to 288 tons, a decrease of 305 tons from 1974 shipments. Approximately 50% of the total was shipped to Canada; the balance was shipped in small parcels to about 18 countries.

Imports of antimony in all forms during 1975, in terms of metal content, were 18,706 tons, a decrease of 15% from the 1974 total. With the exception of antimony oxide, receipts in all categories were lower than in 1974. The sharpest drop was antimony contained in ores and concentrates, which decreased 43% from 1974. The pattern of ore shipments changed during the year, with 10 countries supplying the total requirement compared with 18 countries during 1974. Canada, Guatemala, and Mexico cumulatively increased shipments by 1,598 tons; however, this gain was was more than offset by decreased shipments from Bolivia, Chile, and the Republic of South Africa, which together shipped 6,359 tons less than in 1974. Imports of metal in 1975 dropped slightly to 2,112 tons, a loss of 91 tons from the 1974 total. Supply lines were unchanged from earlier years with reduced shipments of metal from Japan, Mexico, and Yugoslavia essentially balanced by increased tonnages from Belgium-Luxembourg, Italy, Thailand, and the United Kingdom.

Imports of antimony oxide rose 58% above the 1974 receipts to a total of 9,908 tons. Increased shipments were received from the People's Republic of China, Taiwan, and Hong Kong, but receipts from the Republic of South Africa, totaling 6,587 tons, were more than eight times imports in 1974. This unusually high gain in shipments was attributed to full operation of new "value added" facilities that upgraded stibnite ore to an 83% antimony oxide product for refining elsewhere.

Table 10.—U.S. imports for consumption of antimony, by country

Country	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Antimony metal, including needle or liquated: [1]				
Austria	(2)	$2	--	--
Belgium-Luxembourg	142	489	408	$1,064
Bolivia	--	--	42	111
Brazil	17	45	--	--
Canada	1	27	3	30
Chile	--	--	13	37
China, People's Republic of	492	1,993	421	1,361
Czechoslovakia	30	117	--	--
France	(2)	(2)	23	54
Germany, West	(2)	43	(2)	17
Italy	56	204	231	637
Japan	239	1,085	127	332
Korea, Republic of	22	101	--	--
Mexico	442	435	294	807
Netherlands	6	11	11	29
Singapore	--	--	11	20
Spain	22	73	56	141
Taiwan	32	117	22	73
Thailand	86	307	111	257
Turkey	11	47	22	5
United Kingdom	132	488	204	462
U.S.S.R	2	7	--	--
Yugoslavia	557	2,230	187	495
Total	2,289	7,821	2,186	5,932
Antimony oxide:				
Belgium-Luxembourg	499	1,540	214	788
Canada	66	132	--	--
China, People's Republic of	93	311	547	1,896
France	1,334	3,325	572	1,675
Germany, West	32	172	20	44
Hong Kong	--	--	17	67
Italy	46	166	(2)	(2)
Japan	990	3,733	569	1,773
Netherlands	88	351	61	199
South Africa, Republic of	805	229	6,587	1,873
Sweden	--	--	(2)	1
Taiwan	20	81	193	770
U.S.S.R	33	50	--	--
United Kingdom	2,263	5,490	1,128	3,502
Total	6,269	15,580	9,908	12,588

[1] Includes needle or liquated (value in thousands): 1974—Belgium-Luxembourg 56 tons ($174), the United Kingdom 30 tons ($97); 1975—Belgium-Luxembourg 21 tons ($70); the United Kingdom 31 tons ($97); the People's Republic of China 22 tons ($88).
[2] Less than ½ unit.

Table 11.—U.S. imports for consumption of antimony ore, by country

Country	1974 Gross weight (short tons)	1974 Antimony content (short tons)	1974 Value (thousands)	1975 Gross weight (short tons)	1975 Antimony content (short tons)	1975 Value (thousands)
Australia	--	--	--	110	71	$169
Belgium-Luxembourg	353	112	$242	600	308	783
Bolivia	4,380	2,669	3,969	2,639	1,540	4,242
Brazil	76	32	57	--	--	--
Canada	50	10	16	1,012	637	1,426
Chile	3,683	2,283	2,915	--	--	--
Colombia	110	16	15	287	39	48
France	1,928	386	347	--	--	--
Guatemala	1,489	745	308	2,321	1,127	873
Honduras	235	105	97	306	153	136
Malaysia	164	61	99	--	--	--
Mexico	6,638	1,629	781	9,567	2,218	1,730
Morocco	929	421	861	--	--	--
Netherlands	190	76	159	--	--	--
Rhodesia, Southern	396	259	369	--	--	--
South Africa, Republic of	7,873	4,739	8,481	2,986	1,792	4,194
Thailand	1,361	619	1,525	908	435	934
Turkey	816	201	164	--	--	--
United Kingdom	659	292	461	--	--	--
Total	31,330	14,655	20,866	20,736	8,320	14,585

Table 12.—U.S. imports for consumption of antimony

Year	Antimony ore			Needle or liquated		Antimony metal [1]		Antimony oxide	
	Gross weight (short tons)	Antimony content (short tons)	Value (thousands)	Gross weight (short tons)	Value (thousands)	Gross weight (short tons)	Value (thousands)	Gross weight (short tons)	Value (thousands)
1973	33,869	16,679	$10,903	51	$73	692	$745	4,651	$6,095
1974	31,330	14,655	20,866	86	271	2,203	7,550	6,269	15,580
1975	20,736	8,320	14,535	74	255	2,112	5,677	9,908	12,588

[1] Does not include alloy containing 83% or more antimony. Imports for this category is as follows, in short tons: 1973—United Kingdom, 57 ($59,854), Mexico, 21 ($19,858), Belgium-Luxembourg, 20 ($20,216), Canada, 2 ($2,875); 1974—Belgium-Luxembourg, 311 ($883,224), Thailand, 83 ($293,-901), the Netherlands, 44 ($31,988), Czechoslovakia 38 ($138,804), Italy, 33 ($142,831), Yugoslavia, 16 ($71,572), Turkey, 16 ($41,332), Canada, 15 ($48,014), Japan, 6 ($21,711), Mexico, 3 ($908); 1975—Canada, 5 ($3,959), the United Kingdom, 121 ($378,115), the Netherlands, 22 ($88,093), Belgium-Luxembourg, 42 ($115,923), Czechoslovakia, 65 ($199,792), Italy, 181 ($512,073), Yugoslavia, 58 ($116,734), Turkey, 26 ($81,022), Thailand, 24 ($13,623), the People's Republic of China, 6 ($13,998).

WORLD REVIEW

World mine production in 1975 dropped slightly to 74,802 tons, a decrease of some 4,500 tons from 1974. No major changes occurred in distribution of output by countries. Moderate increases in production by Canada, Mexico, and the Republic of South Africa were offset by small decreases in Bolivia, Italy, Yugoslavia, and Thailand.

Australia.—Production of antimony in Australia continued along traditional lines during 1975 as several new properties were readied for startup. Silver Valley Minerals NL, concentrated activity at its new mine near Armidale, New South Wales. Underground development was completed, delineating a high-grade deposit that also contains gold. When the mine goes into production, it is expected that ore will be treated at the company's nearby Tulloch plant.

Australian Antimony Corp. NL began production at its new mine at Dorrigo on the north coast of New South Wales. About 103 tons of antimony concentrate was produced before putting the mine on a care and maintenance basis for economic reasons.

Metramor Minerals Ltd., in a joint venture with Australian Anglo-American Ltd., continued development of the Blue Spec antimony mine near Nullagine in the Pilbara district. Sampling to date has outlined 80,000 tons of proven ore reserves assaying 4.63% antimony.

Bolivia.—Bolivia with about 13,002 tons of antimony ranked as the world's second largest producing country during 1975. Recent changes have restructured the industry along the following lines. Banco Minero de Bolivia, a State-owned company, acts as a buying agent for small- and medium-size mines, providing them with a market outlet and centralized source of revenue. Banco Minero in turn, resells the ore or concentrates to either the Bolivian antimony smelter or consumers in the world market.

Empresa Minera Unificada S.A. (EMUSA), a privately owned company, produced antimony ore and concentrate for export as well as consumption in Bolivia. Some of the larger properties included the Chilcobija, Caracota, and Espiritu Santo mines.

Empresa Nacional de Fundiciones (ENAF) in consort with Corporación Minera de Bolivia (COMIBOL) operated an antimony smelter at Oruro, with capacity of 5,000 tons of metal and 1,000 tons of oxide per year. Plans for future expansion are being evaluated in 1975.

China, People's Republic of.—The People's Republic of China was believed to be the third largest producer of antimony in 1975, with an estimated mine production of 13,000 tons. Probably 6,000 to 8,000 tons was exported as metal and in ores and concentrates. Most of the antimony mined in China comes from the Province of Hunan, which is reported to contain about 60% of the total Chinese reserve.

Mexico.—Mexican production of antimony in 1975 increased about 30% to 3,460 tons compared with 1974 production. Deposits of antimony have been identified in 14 States; however, production in 1975 was primarily from the State of San Luis Potosi. Most of the antimony mined in Mexico was shipped to Laredo, Tex., for smelting and refining at the plant of NL Industries, Inc.

South Africa, Republic of.—Production of antimony during 1975 totaled about 17,500 tons. The major producer was Consolidated Murchison Ltd., which operated a mine and processing plant in the Letaba district of the Transvaal and produced about 16,200 tons of antimony. Output was in the form of cobbed ore and antimonial and arsenical concentrates which assayed about 59% to 60% antimony. A significant portion of the concentrates was treated at the crude oxide plant of Antimony Products Pty. Ltd. located near the mine. Antimony Products upgraded the raw material to a crude oxide, which was exported for further refining.

Thailand.—Thailand produced approximately 3,450 tons of antimony during 1975, a slight decline from 1974, reflecting a lack of demand from consuming markets. There was a total of 50 antimony mine lease holders in 1975, 33 of which were located in the northern region. The Provinces of Olampang and Phrae appear to have the greatest potential, but development has been hampered by high production costs and low economic return.

Table 13.—Antimony: World production (content of ore unless otherwise indicated), by country

(Short tons)

Country	1973	1974	1975 p
North America:			
Canada [1]	r 830	e 1,380	e 1,450
Guatemala	r 962	480	944
Honduras	r 54	149	113
Mexico [2]	2,632	2,653	3,458
United States	545	661	886
South America:			
Argentina	1	2	e 6
Bolivia	[3] 16,461	[4] 14,396	[4] 13,002
Ecuador	22	--	--
Peru (recoverable) [2]	756	751	805
Europe:			
Austria (recoverable)	593	551	612
Czechoslovakia e	r 770	r 830	880
Italy	1,497	1,297	1,036
Portugal	r 32	--	--
Spain	126	148	90
U.S.S.R. e	7,300	8,000	8,300
Yugoslavia	2,265	e 2,434	e 2,240
Africa:			
Algeria e	66	e 66	66
Morocco	1,364	2,029	1,313
Rhodesia, Southern e	220	330	330
South Africa, Republic of	17,306	16,722	17,552
Asia:			
Burma	158	183	239
China, People's Republic of e	13,000	13,000	13,000
Korea, Republic of	12	--	--
Malaysia (Sarawak)	276	220	e 220
Pakistan e	r 9	r 36	33
Thailand	3,763	4,669	3,454
Turkey	3,696	6,482	3,773
Oceania: Australia [5]	r 1,704	1,763	e 1,500
Total	r 76,920	79,232	74,802

e Estimate. p Preliminary. r Revised.
[1] Antimony content of smelter products, excludes output from New Brunswick, which is believed to be small.
[2] Antimony content of ores for export plus antimony content of antimonial lead and other smelter products produced.
[3] Production by COMIBOL plus exports of medium and small miners.
[4] Total exports.
[5] Antimony content of antimony concentrates, lead concentrates and zinc concentrates.

TECHNOLOGY

A new procedure for preparing high-purity antimony as related to production of high-purity antimony trioxide was discussed.[2] Application might be in the electronic and computer industries as a semiconductor component.

Interaction of antimony oxide with certain other elements was presented as a concept for improved performance with molybdenum disulfide in specialty lubricants.[3]

[2] Jevtic, J., and D. Vitorovic. Antimony Metals. I&EC Prod. Res. and Develop., v. 13, December 1974, pp. 275–279.
[3] Lavik, M. T. Oxide Interaction. Lubrication Eng., v. 31, January 1975, pp. 20–22.

Asbestos

By Robert A. Clifton [1]

Shipments of asbestos from mines in the United States decreased 12% from those in 1974. There was no decrease in demand for domestic asbestos; all the operating mines were producing at capacity. The decrease in total production was because mines that closed in 1974 had some production that year before closing. Imports were only 70% of those in 1974. The Canadian strike was the principal causative agent for this, but demand also dropped some during the recession.

Canada relinquished, at least temporarily, its claim as the world's primary producer of asbestos. Canadian 1975 production was only 63% of that in 1974 and its shipments to the U.S. only 68% of those in 1974. Imports from the U.S.S.R. were nearly 2% of the total U.S. imports.

Table 1.—Salient asbestos statistics

	1971	1972	1973	1974	1975
United States:					
Production (sales) ---- short tons --	130,882	131,663	150,116	112,533	98,654
Value --------------- thousands --	$12,174	$13,409	$16,288	$13,759	$14,220
Exports and reexports (unmanufactured) --- short tons --	53,678	58,624	66,442	61,723	36,447
Value -------------- thousands --	$7,863	$9,051	$9,342	$9,192	$10,667
Exports and reexports of asbestos products (value) ----- thousands --	$31,409	$32,110	$40,777	$60,396	$60,776
Imports for consumption (unmanufactured) --- short tons --	681,367	735,515	792,473	766,164	538,553
Value -------------- thousands --	$80,090	$87,732	$98,914	$123,822	$111,011
Released from stockpile (unmanufactured) --- short tons --	10,210	13,174	6,761	28,851	6,877
Consumption, apparent [1] - short tons --	768,781	821,728	882,908	845,825	607,637
World: Production ------------- do ----	3,951,373	4,163,675	r 4,613,717	r 4,588,760	4,508,985

r Revised.
[1] Measured by quantity produced, plus imports, plus stockpile release, minus exports.

Legislation and Government Programs.—The event of 1975 with the most potential for impact on the asbestos industry was the proposed regulations published by the Office of Safety and Health Administration (OSHA) on October 9, 1975, in the Federal Register. The proposal contained no mandatory effective date. The most important change in the regulations as proposed would be a reduction in the level of permissible exposure to 0.5 fiber per cubic centimeter of air on a time-weighted average over an 8-hour day. The present permissible level is 5.0 fibers per cubic centimeter due to drop to 2.0 fibers on July 1, 1976.

The proposal excluded those activities where exposure came during construction and provides additional requirements for regulated areas, employee rosters, hygiene facilities, training and information programs, labels and signs, and monitoring and medical surveillance programs.

The asbestos industry applied for and received an extension of the closing time for receipt of comments and raised strong objections to the proposed regulations.

Less than a week after the publication of the OSHA proposal, the Environmental Protection Agency (EPA) promulgated, on

[1] Physical scientist, Division of Nonmetallic Minerals.

October 14, new air pollution control regulations. These require generators of asbestos-containing wastes to dispose of them in sanitary landfills. Inactive sites are now regulated and owners must provide such sites with 6 inches of vegetated cover or 2 feet of cover without vegetation. Incineration of asbestos containers is permitted provided that there are no visible emissions.

Drawdown of stockpile inventories continued as shown in table 2. Crocidolite stocks are practically depleted, and there was at least a temporary stop to chrysotile releases.

On September 25 the House of Representatives voted down (209 to 187) H.R. 1287, which would have repealed the Byrd Amendment that permits U.S. purchases of Rhodesian asbestos.

Table 2.—Stockpile objectives and Government inventories as of December 31
(Short tons)

	Stockpile objectives	Total inventories		Released 1975
		1974	1975	
Amosite	None	46,593	42,815	3,778
Chrysotile	1,100	10,455	10,455	--
Subspecification	XX	1,153	500	653
Crocidolite	None	2,478	32	2,446
Total	XX	60,679	53,802	6,877

XX Not applicable.

Environmental Impact.—It is impossible to completely assess the impact on the asbestos industry of environmental regulations. The market shortages occasioned by the Canadian strike, when coupled with increasing regulation, intensified the efforts of several companies to find substitutes for asbestos in their products. The return of a normal market situation may indeed indicate that some market segments are lost to asbestos.

The effects of environmental regulations on the asbestos mining industry are still hard to judge. The Vermont Asbestos Group Inc., expects to be in full compliance with EPA regulations in the spring of 1976 without undue economic hardship. A group of West German and American investors bought and is refurbishing the Copperopolis, Calif., mine closed in 1974 by H. K. Porter Co., Inc. This group, Calaveras Asbestos Ltd., fully expects to operate profitably under full compliance.

DOMESTIC PRODUCTION

U.S. mines shipped only 88% as much asbestos in 1975 as in 1974. The value was 3% higher than the 1974 amount. Four States produced asbestos; California was the leader, followed in order by Vermont, Arizona, and North Carolina. Total output was 98,654 tons valued at $14,220,000.

The California segment of the asbestos industry again reported a decline in production. The full effect of the closing of the Coalinga Asbestos Co.'s Christie mine and that of the Pacific Asbestos Corp. mine was felt in 1975. These mine closures resulted in a production of only 97% of the 1974 State total. However, an increase of 6% over the 1974 dollar value of the fiber was realized. By yearend Calaveras Asbestos Ltd. was successful in the acquisition of the Pacific Asbestos mine. Production was scheduled to begin early in 1976. Yearend mining was limited to the Joaquin Ridge near Coalinga with Atlas Asbestos Corp. working its Santa Cruz mine in Fresno County and Union Carbide Corp. operating its Santa Rita mine in San Benito County.

The Vermont Asbestos Group Inc. mine in Orleans County, Vt., remained the U.S. asbestos mine with the highest production, although its output decreased significantly from that in 1974. This mine was scheduled for closure by GAF Corp. in March of 1975 but was purchased by an employee group, which has been highly successful in efforts to keep it operating. Arizona production in 1975 was 62% above the 1974 level. The Jaquays Mining Corp. mine in Gila County was the only active asbestos mine in the State. The mine of North Carolina's Powhatan Mining Co. was inactive, but some 540 tons of anthophyllite were mined and shipped from somewhere in the United States in 1975. Indications are that it was from North Carolina. U.S. asbestos producers and mine sites follow:

State and company	County	Name of mine	Type of asbestos
Arizona: Jaquays Mining Corp	Gila	Chrysotile	Chrysotile.
California:			
Atlas Asbestos Corp	Fresno	Santa Cruz	Do.
Calaveras Asbestos Ltd.[1]	Calaveras	Copperopolis	Do.
Union Carbide Corp	San Benito	Santa Rita	Do.
North Carolina: Powhatan Mining Co.[2]	Yancey	Hippy	Anthophyllite.
Vermont: Vermont Asbestos Group Inc.	Orleans	Lowell	Chrysotile.

[1] Closed during 1975; due to open early 1976.
[2] Inactive.

CONSUMPTION AND USES

Further analysis of the data available from the 1974 asbestos consumption survey reveals that 18,000 tons of asbestos were released from industry stocks and not replaced during 1974 and that the true (rather than apparent) consumption figure for that year would be 864,000 tons. Industry stocks at the end of 1974 were 103,000 tons.

Analysis of the 1975 consumption data reveals the fact that in spite of the very real shortages of 1975, industry stocks were slightly higher at yearend than at the beginning. True consumption would be somewhat less than 600,000 tons.

Comparisons between the end uses for 1974 and 1975 would seem to be an exercise in futility because of the inability to distinguish between decreased asbestos product production caused by fiber shortage and that caused by economic recession. It is extremely interesting to note that "textile fiber" imports in 1975 were only 30% of those in 1974. Whether this is trend indicative or not will have to await data from more normal years.

Table 3.—Asbestos distribution by end use, grade, and type, 1975
(Short tons)

	Chrysotile											
	Group 1 and 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Total chrysotile	Crocidolite	Amosite	Anthophyllite	Total asbestos
Asbestos cement pipe	--	2,300	90,200	31,700	--	2,500	--	126,700	21,200	5,300	--	153,200
Asbestos cement sheet	--	100	6,000	6,500	19,400	6,500	--	38,500	--	5,400	100	44,000
Flooring products	--	--	--	100	--	135,700	--	135,800	--	--	--	135,800
Roofing products	--	--	1,500	4,300	8,900	31,000	--	45,800	--	600	--	46,400
Packing and gaskets	200	700	3,100	7,600	400	4,800	--	16,800	100	--	--	16,900
Insulation, thermal	--	--	400	300	2,700	700	--	4,100	--	500	--	4,600
Insulation, electrical	--	--	100	100	--	1,200	--	1,400	--	--	--	1,400
Friction products	--	2,900	800	22,000	6,100	23,100	200	65,100	--	500	500	66,100
Coatings and compounds	200	900	800	100	100	29,400	--	31,500	--	--	--	31,500
Plastics	--	200	800	1,000	--	11,700	--	13,700	1,200	--	--	14,900
Textiles	700	5,200	100	100	--	--	--	6,100	--	--	--	6,100
Paper	--	100	5,000	1,400	30,500	28,700	--	65,700	200	--	--	65,900
Other	--	1,300	1,600	2,600	4,700	9,300	--	19,500	--	500	800	20,800
Total	1,100	13,700	110,400	77,800	72,800	294,700	200	570,700	22,700	12,800	1,400	607,600

In 1975 asbestos cement pipe was still the largest single use for asbestos with better than 25% of the consumption. Asbestos cement sheet was the sixth largest use at over 7%. Flooring products at 22% was second. If the near 8% used in roofing products is added to the previously mentioned three uses, these construction industry products still account for nearly two-thirds of U.S. asbestos use. The other major asbestos-containing end products are friction materials at 10.9%, paper at 10.8%, and coatings and compounds at 5.2%. Plastics used better than 2% of the asbestos total.

PRICES

Quoted prices for Quebec asbestos rose more than 23% during 1975 with the last rise effective on December 1, 1975. British Columbia asbestos prices rose more than 30% during the year in two steps, the last one effective August 1, 1975.

Prices for some grades of Arizona chrysotile asbestos were raised on April 17, 1975. Quotations, f.o.b. Globe, were as follows:

Grade	Description	Per short ton
Group No. 1	Crude	$2,000
Group No. 2	do	1,500
AAA		1,100
Group No. 3	Nonferrous filtering and spinning	$715– 800
Group No. 4	Nonferrous plastic and filtering	700– 800
Group No. 7	White shorts	100– 200

As of June 16, 1975, Vermont chrysotile asbestos, f.o.b. Morrisville, was priced as follows:

Grade	Description	Per short ton
4A through 4T	Fiber	$360–$608
5D through 5R	do	238– 280
6D	Waste	173
7D through 7T	Shorts	77– 150
7TF	Floats (shorts)	66
8S	Shorts	53
Hooker No. 1	Packaged in 50-pound woven polyvinyl bags	850
Hooker No. 2	Packaged in 100-pound woven polyvinyl bags	425

Quotations for Canadian (Quebec) chrysotile, f.o.b. mine, were as follows, as of December 1, 1975:

Grade	Description	Per short ton
Group No. 1	Crude	Can$3,496
Group No. 2	do	1,879
Group No. 3	Spinning fiber	Can$891–1,463
Group No. 4	Asbestos-cement fiber	492– 829
Group No. 5	Paper fiber	278– 392
Group No. 6	Waste, stucco, or plaster	236– 244
Group No. 7	Refuse or shorts	89– 198

Prices for British Columbia and Yukon Territory, Canada, chrysotile asbestos were effective August 1, 1975. Quotations, f.o.b. Vancouver, were as follows:

Grade	Description	Per short ton
Cassiar mine:		
C-1	Crude	Can $2,916
AAA	Nonferrous spinning fiber	1,685
AA	do	1,340
A	do	1,020
AC	do	735
AK	Asbestos cement fiber	524
AS	do	454
AX	do	416
AY	do	292
AZ	do	216
Clinton mine:		
CP	do	492
CT	do	445
CY	do	292
CZ	do	216

African asbestos producers privately negotiate sales and this rules out market quotations. The following are averages, regardless of grade, of the values of South African imports, calculated from U.S. Department of Commerce data:

Type	Per short ton				
	1971	1972	1973	1974	1975
Amosite	$164	$187	$188	$228	$395
Crocidolite	212	211	213	251	427
Chrysotile	120	202	234	282	940

The increased demand for and unavailability of asbestos in all categories plus increased mining costs resulted in price increases almost across the board. Other price rises are expected early in 1976.

FOREIGN TRADE

The value of exports of asbestos products manufactured in the United States showed little change from 1974 to 1975. This is noteworthy when numbers of articles exported decreased. There were more than 1,000,000 fewer clutch facings shipped abroad in 1975 than in 1974.

Major groupings of exported products and their share of the total value were friction products (36%), packing and gaskets (20%), asbestos cement products (13%), textiles and yarns (12%), and insulation products (8%).

In 1975, 64% of the cost of imported asbestos was recovered by the exporting and reexporting of fibers and products.

In 1975 the United States imported 89% of its asbestos consumption. This was below the 1974 percentage. Canada provided better than 93% of the imports, the Republic of South Africa provided 3%, the U.S.S.R. 2%, and nine other countries provided the remainder. Chrysotile, with 97%, dominated the imported types. The dollar value of imported fibers was 90% of that in 1974.

Table 4.—U.S. exports and reexports of asbestos and asbestos products

Products	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
EXPORTS				
Unmanufactured:				
Crude and spinning and nonspinning fibers short tons	22,633	$6,069	15,173	$6,067
Waste and refuse do	32,481	2,574	19,748	3,992
Total do	55,114	8,643	34,921	10,059
Products:				
Gaskets and packing do	3,235	12,582	2,643	12,401
Brake linings do	5,924	10,136	4,856	9,374
Clutch facings, including linings number	2,429,537	2,503	1,359,914	1,598
Textiles and Yarn short tons	9,465	8,408	5,732	7,284
Shingles and clapboard do	12,345	3,348	14,277	4,649
Articles of asbestos cement do	31,275	7,715	18,952	7,628
Protective clothing	NA	556	NA	810
Insulation, heat and sound	NA	4,541	NA	5,072
Manufactures, n.e.c	NA	10,467	NA	11,740
Total	XX	60,256	XX	60,556
REEXPORTS				
Unmanufactured:				
Crude and spinning and nonspinning fibers short tons	2,129	548	1,391	573
Waste and refuse do	4,480	1	135	35
Total do	6,609	549	1,526	608
Products:				
Gaskets and packing do	5	17	2	21
Brake linings do	34	39	127	145
Clutch facings, including linings number	14,504	21	27,645	16
Textiles and yarn short tons	47	12	1	11
Shingles and clapboard do	28	8	--	--
Articles of asbestos cement do	45	5	NA	6
Manufactures, n.e.c	NA	38	NA	21
Total	XX	140	XX	220

NA Not available. XX Not applicable.

Table 5.—U.S. imports for consumption of asbestos from specified countries, by grade
(Short tons)

Grade	1974 Canada	1974 Southern Rhodesia	1974 Republic of South Africa	1975 Canada	1975 Southern Rhodesia	1975 Republic of South Africa
Chrysotile:						
Crudes	115	1,717	987	71	1,633	940
Spinning fibers	26,768	4	66	7,637	382	115
All other	712,228	--	3,291	495,837	608	1,457
Crocidolite (blue)	--	--	11,302	--	--	11,570
Amosite	--	--	8,018	--	--	3,894
Total	739,111	1,721	23,664	503,545	2,623	17,976

Table 6.—U.S. imports for consumption of asbestos (unmanufactured), by class and country

Year and country	Crude (including blue fiber) Quantity (short tons)	Crude (including blue fiber) Value (thousands)	Textile fiber Quantity (short tons)	Textile fiber Value (thousands)	All other Quantity (short tons)	All other Value (thousands)	Total Quantity (short tons)	Total Value (thousands)
1974								
Brazil	--	--	--	--	20	$2	20	$2
Canada	115	$13	26,768	$10,416	712,228	106,085	739,111	116,514
Finland	--	--	--	--	557	74	557	74
Germany, West	99	35	--	--	1	1	100	36
Italy	--	--	1	4	--	--	1	4
Mexico	--	--	--	--	55	11	55	11
Portugal	--	--	--	--	4	2	4	2
Rhodesia, Southern	1,717	1,010	4	2	--	--	1,721	1,012
South Africa, Republic of	20,307	5,157	66	16	3,291	510	23,664	5,683
Swaziland	480	361	--	--	--	--	480	361
U.S.S.R	--	--	--	--	451	123	451	123
Total	22,718	6,576	26,839	10,438	716,607	106,808	766,164	123,822
1975								
Belgium-Luxembourg	22	3	--	--	48	5	70	8
Canada	71	9	7,637	5,772	495,837	91,791	503,545	97,572
Finland	--	--	--	--	329	33	329	33
Gaza Strip	--	--	--	--	152	26	152	26
Italy	--	--	--	--	197	37	197	37
Mexico	--	--	--	--	73	15	73	15
Mozambique	118	16	--	--	--	--	118	16
Rhodesia, Southern	1,633	1,521	382	369	608	380	2,623	2,270
South Africa, Republic of	16,404	7,147	115	100	1,457	459	17,976	7,706
Swaziland	2,756	952	--	--	--	--	2,756	952
U.S.S.R	4,525	921	--	--	5,854	1,361	10,379	2,282
United Kingdom	277	83	--	--	58	11	335	94
Total	25,806	10,652	8,134	6,241	504,613	94,118	538,553	111,011

WORLD REVIEW

The following quote,[2] from an in-depth article in a Canadian mining periodical, fairly well describes what happened to Canadian production in 1975, which left much of the world demand unsatisfied:

"Inflation, recession, landslides and strikes have contributed to a troubled year for a large segment of the asbestos industry. Environmentalists and the media have damaged the image of this extremely important mineral. In spite of all this, the industry is shaking off the effects of these unforeseen mishaps and conditions and should end the year alive and well—and in a position to resume a normal growth pattern."

"Canada's position as the world's leading producer has not been challenged and there is no serious rival in sight. This is due, for the most part, to the quality of the chrysotile fibre which makes up the bulk of our production, and the high standard of the marketed products."

Another magazine[3] with worldwide distribution and a less parochial viewpoint put this in context with the world supply-demand situation of the last few years when it said at the beginning of its lead article in June:

"In common with many other industrial minerals (and many other commodities), asbestos experienced extremely strong demand throughout 1974, which was reflected in higher prices, shortages in certain areas, and producers operating at capacity levels. This year's recession in Western industry appears to have taken the heat out of the majority of mineral markets, however, with significant falls in both demand and prices. Not so asbestos! Demand continues to exceed supply, and after price rises averaging over 50% between the end of 1973 and the beginning of 1976, yet another rise is expected shortly—and all this even though two of asbestos' major consuming areas—the construction and the motor manufacturing industries—are operating at low levels. This paradox cannot be explained simply. The continuing short supply has in fact been brought about

[2] Northern Miner. Asbestos Weathers Storm. V. 61, No. 37, Nov. 27, 1975, p. B-12.
[3] Industrial Minerals. Asbestos. No. 93, June 1975, pp. 19-24, 26-31, 33.

by a combination of factors—producer problems, ranging from a fire and landslide to strikes and other political pressures; supply problems, such as shipping difficulties and the like; and continuing strong demand, particularly from the developing countries. In addition, the whole industry from mining to manufacturing, is undergoing extensive changes as new and wider controls are introduced to counter the much-publicized health hazards associated with asbestos usage."

As expected there were significant price increases for asbestos in 1975 led by an approximate 23% rise in the published prices of Quebec fibers.

Australia.—The Woodsreef mine seems to be turning the corner toward solvency. There was very little deficit in the quarter ended October 31, 1975. If production were maintained at that quarter's rate, the annual production of asbestos fibers would near 60,000 tons. The company has identified four other asbestos prospects in New South Wales and applied for exploration licenses for them.

Canada.—Canadian asbestos production (all chrysotile) during 1975 was only 63% of that during 1974. The economic recession of that year was not to blame as producers sold all of their production that was available after a fire, a landslide, and a strike.

The bad year began, actually, in December 1974 when the fire that destroyed the King-Beaver mill of Asbestos Corp. Ltd. in Thetford Mines reduced that company's capacity for fiber production from 150,000 to 100,000 tons per year in that locality. Reserve updating was necessary prior to mill replacement planning. As a strike prevented the needed drilling for 7 months, no decision had been made by yearend. The Asbestos Hill mine of Asbestos Corp. Ltd. in Ungava was not bothered by the Thetford Mines misfortunes. It produced 42% more fiber concentrate than in 1974 and shipped 48% more of the concentrate to the mill at Nordenham, West Germany.

The Jeffrey mine of Canadian Johns-Manville Co. suffered a major landslide in January of 1975, which cut shipments for the year to 93% of the 650,000 tons of fiber shipped in 1974. A return to full production was reached in October with record high shipments and another record was set in December. Although the labor contract between Johns-Manville and their employees expired at approximately the same March date as that of other asbestos producers in the area, the union and management agreed to terms before a strike was called.

In March the 3,500 employees of the four companies producing asbestos in the Thetford Mines area struck for higher wages and better working conditions. Although two unions were representing the workers of Asbestos Corp., Ltd., Bell Asbestos Mines Lt., Carey-Canadian Mines, Ltd., and Lake Asbestos of Quebec, Ltd., they had unanimity of purpose and remained on strike for 7 months. The basic hourly wage rose immediately from $3.73 to $5.21 and to $6.59 by September 1, 1977. The Quebec Asbestos Mining Association estimated that the total package would come to about a 45% to 50% increase over the 2-year tenure of the contract.

Advocate Mines, Ltd., announced the finding of a possible asbestos ore body 12 miles from its Baie Verte operation. Diamond drilling was being expedited.

Cassiar Asbestos Corp. Ltd. started operating a new tramline and primary crusher plant at its Cassiar, British Columbia, mine in September. This mine was also the scene of a 3-week strike in early winter of some 400 workers over health and safety conditions.

At yearend the new mine and mill of United Asbestos Inc. at Midlothian Township in Ontario had reached the tuneup stage. Brinco Ltd. at that time had reached a new $260 million estimate of the capital costs of bringing into production the Abitibi Asbestos Mining Co. property in Maizerete Township, Quebec. It was estimated that it would take 3 years to enter full production once the decision to proceed was made. Evaluation and testing of the Chibougamau, Quebec, deposit of the McAdam Mining Corp. were continued by Rio Algom Limited.

On December 15, Acting Environment Minister Romer LeBlanc announced a federal limit of 2 fibers per cubic centimeter in the air surrounding asbestos mining, milling, and dry rock storage areas. He cited the Clean Air Act as authorization.

China, People's Republic of.—An article in a Chinese newspaper[4] describes the Shiehmien (meaning asbestos) mine in Szechwan Province. The mine is described

[4] Takungpao. Asbestos in Szechwan. Aug. 31, 1974, p. 8.

as having an ore body 6,300 meters long by 350 meters wide containing more than 28 million tons of ore grading over 2%. The use of modern techniques and machinery such as aerial tramways and trucks have increased production from 50 tons to "tens of thousands of tons" (could be per month). The article claims that more than half of the fibers exceed 2 millimeters (0.08 inch) in length. During 1975 China started advertising the availability of such asbestos-containing articles as yarn, packing, lagging, and cloth.

Cyprus.—The 1973 troubles on the Island failed to disrupt Cyprus' production and export of asbestos. The 1974 export figure was nearly 13% above that of 1973.

Finland.—After 58 years of operation the Paakkila anthophyllite mine of Paaristen Kalkki Oy was closed in January. Marketing problems and labor shortages were among the determining factors. The mill remained open through June. Some African anthophyllite mines have developed grades corresponding to the Finnish ones and these are available on the world market.

India.—With assistance from the United Nations Development Program, a new asbestos processing facility was scheduled to be under construction by late 1975 in India. The site was at the Cuddapah area of Andra Pradesh where there was estimated to be reserves of 27,000 tons.

South Africa, Republic of.—Some intriguing indications are to be found in the preliminary 1975 statement of Griqualand Exploration and Finance Co. (Gefco). Their Kiruman mine in Cape Province is reportedly the world's largest source of blue (crocidolite) asbestos with a nominal 55,000-ton annual production in the last few years. They claim a worldwide shortage of "blue" in spite of no sales in the United Kingdom, a looming ban in Canada, and many environmentalists calling crocidolite the most unhealthy of fibers. Gefco shows an astounding 49% rise in unit cost of production, but it is clear that sales have risen substantially over 1974.

Sweden.—Sweden's industrial health board banned the use of asbestos in building insulation, soundproofing, and most other purposes except fireproofing, effective October 1. Action followed findings that eight lung cancer deaths among workers at the Nohab Machine Works in Trollhattan between 1959 and 1969 were attributable to the fact that Nohab used asbestos as an insulating material for locomotive-engine exhaust pipes.

U.S.S.R.—In 1975, asbestos production (six grades) in the U.S.S.R. passed the 2-million-short-ton mark for the first time, surpassed Canadian production for the first time, and the estimated 600,000 tons exported exceeded Canada's exports for the first time. More than half of the exports were to countries other than those with centrally controlled economies in spite of a domestic deficit of an estimated 110,000 tons.

The U.S.S.R. asbestos industry is centered in the Urals, Kazakhstan, and Tuva A.S.S.R. The Uralasbest complex produced an estimated 1.4 million tons in 1975. In the southern Urals the development of the Kiembayev deposit in Oranburg Oblast continued. This effort, underwritten by seven Council for Mutual Economic Assistance (Comecon) members, has a design capacity of 550,000 tons and the first of two equal construction stages is due to begin operation in 1978. Output will be shared with the participating Comecon members.

Kazakhstan has the U.S.S.R.'s second largest asbestos deposit, Dzhetygara, in Kustanay Oblast. Renovation of the No. 1 mill and commissioning of the new No. 2 mill permitted production of about two-thirds of a million tons in 1975.

The high quality, long fiber, deposit at Aktourak in Tuva A.S.S.R. produced about 38,000 tons of asbestos in 1975.

Design of the complex to exploit the Molodeshny deposit in Buryat A.S.S.R. was completed in 1974, but construction will not be started until completion of the western section of the Kaykal-Amur railroad.

Yugoslavia.—Ore from the Stragari mine of Stragari Asbest located at Stragari, Serbia, was tested in the laboratories of the Mining Institute in Zemun during 1975. The new fiber recovery technology developed is being installed and should be in use in 1976. Design production capacity is 5,000 tons of fiber per year.

Table 7.—Asbestos: World production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Canada (sales)	1,862,976	1,824,000	1,140,000
Mexico	17	6	29
United States (sold or used by producers)	150,116	112,533	98,654
Latin America:			
Argentina	683	988	[e] 1,000
Brazil	[r] 49,458	68,201	[e] 72,000
Europe:			
Bulgaria	[r] [e] 14,000	28,000	24,000
Finland [2]	6,985	6,165	3,073
Italy	[r] 165,629	163,251	162,018
Portugal	[e] 140	198	[e] 220
U.S.S.R.[e]	[r] 1,410,000	1,500,000	2,090,000
Yugoslavia	10,352	13,500	14,330
Africa:			
Egypt	363	312	528
Mozambique	624	209	--
Rhodesia, Southern [e]	[r] 180,000	[r] 180,000	[r] 180,000
South Africa, Republic of	[r] 368,435	367,369	391,000
Swaziland	40,675	35,738	41,447
Asia:			
China, People's Republic of [e]	230,000	[r] 165,000	165,000
Cyprus	34,950	30,959	34,835
India	[r] 13,735	21,310	22,654
Japan	9,100	5,710	5,084
Korea, Republic of	6,291	6,294	4,030
Taiwan	5,851	3,964	1,915
Thailand	91	[e] 110	[e] 110
Turkey	[r] 5,264	17,181	17,058
Oceania: Australia	[r] 47,982	37,762	[e] 40,000
Total	[r] 4,613,717	[r] 4,588,760	4,508,985

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, Czechoslovakia, North Korea, and Romania also produce asbestos, but available information is inadequate to make reliable estimates of output levels.
[2] Includes asbestos flour.

TECHNOLOGY

The shortages of asbestos resulting from the Quebec strike, the price increases resulting from this and other inflationary pressures, and the very real problems associated with environmental control of exposure to asbestos put added pressure on the perennial search for asbestos substitutes.

These things were discussed in a national magazine,[5] excerpts from which appear below:

"Our suppliers have a 'spear your friends' policy," said a midwest friction products manufacturer. "Because of that policy many of our materials costs have doubled in the past 12 months."

A New England producer of packing and seals ". . . is studying the use of Teflon and graphite fibers as substitutes for asbestos. He admits 'for the time being asbestos is still a critical material for this company's products.' "

A midwest boiler gasket producer asserts, "Asbestos is close to pricing itself out of the market. Ceramic materials have been around for some time that would replace asbestos in some applications, but in the past they were too expensive. Now they are looking a lot more attractive."

A western manufacturer tried substituting mineral wool and fiberglass in flooring materials but, "We found there's really no replacement for asbestos."

Although the aforementioned article cited the fears of one asbestos cement pipe manufacturer about the convergence of costs of competing products, there is a factor probably overlooked: Energy. An extract in a trade magazine[6] covers the situation well: ". . . recent statistical evaluations carried out in the United States showed that the production of asbestos-cement pipes required only one-eighth of the energy needed to produce a similar length of cast iron pipes and one-quarter of the energy needed for PVC pipes. In

[5] Business Week. The Seller's Market in Asbestos. No. 2411, Dec. 15, 1975, p. 49.
[6] International Asbestos Cement Review. Asbestos-Cement—An Industry in Decline or Facing Further Expansion. Declan Grehan, v. 20, No. 1, January 1975, pp. 27-30.

this calculation the entire energy consumption was taken into account, that used in the mining of asbestos, crushing and purifying the ore, transporting it and that of asbestos-cement manufacture up to the factory stockyard."

That there is still ongoing effort to substitute glass fiber for asbestos in reinforced cement products is evidenced by the recent agreement between Pilkington Brothers Ltd. of England and Owens-Corning Fibreglas Corp. of the United States. Under the agreement Pilkington will share its know-how of its alkali-resistant glass fiber with its American ally.

The Du Pont Corp. is diligently seeking new markets for its aramid fiber "Nomex," which already has wide acceptance in the protective clothing field and some acceptance as a tire fiber.

According to Chemical Engineering[7] the Japanese Government's decision to outlaw mercury cells in chlor-alkali plants has pushed two companies (one presently using Du Pont's Nafion membranes) into developing their own synthetic membrane diaphragms to replace the asbestos diaphragms of the mercury cells. The fast developing technology is apparently economical as well as environmentally preferable. This market for asbestos fibers may be slowly closing.

A whole family of ceramic fibers is now available according to a national magazine[8] and for temperatures above 1,000° F (811 K) they are excellent insulation materials. Some of the newer ones have service temperatures up to 3,000° F (1,922 K). They are lightweight, flexible, longlived, and expensive. Prices range from \$.65 to \$25 per pound. Typical properties are shown in table 8.

Not all technological advances have been in the area of asbestos substitutes. Raybestos-Manhattan, Inc. announced a processing sequence that keeps asbestos immersed throughout production of its "Novatex" asbestos yarns. This suppresses process dust and contains a binder that will keep the fibers locked in during further processing. The same company has a new British patent on a method of preparation of asbestos containing synthetic yarns.

Table 8.—Typical properties of ceramic fibers

Property	Alumina [1]	Alumina-boria-silica [2]	Alumina-chromia-silica [3]	Alumina-silicate [4]	Silica [5]	Zirconia-silica [6]	Zirconia [7]
Specific gravity	3.5	2.5	2.8	2.56	2.0–2.2	3.7	5.5
Melting point ° F	3,600	3,300	3,200	3,200	3,100	3,650	4,900
Melting point K	2,255	2,089	2,033	2,033	1,977	2,283	2,977
Maximum use temperature ° F	2,750	2,370	2,550	2,300	2,400	1,830	2,750
Maximum use temperature K	1,783	1,573	1,673	1,533	1,589	1,273	1,783
Specific heat Btu/lb F	.25	--	--	[8] 255	[9] 26	--	.14
Specific heat j/kg	1,046	--	--	1,066.9	1,087.8	--	585.8
Tensile strength 1,000 psi	150	250	200	190	100	150	100
Tensile strength MPa	1,034	1,723.8	1,379	1,310.1	689.5	1,034	689.5
Tensile modulus 10^6 psi	15.0	22.0	23.0	16.8	--	14.0	15.0
Tensile modulus 10^5 MPa	1.034	1.52	1.58	1.158	--	.965	1.034
Elongation at break %	--	1.2	1.2	--	--	1.1	--
Mean diameter μm	3	11	10	2.8	10	14	3
Mean diameter 10^{-6} m	3	11	10	2.8	10	14	3
Surface area 10^3 sq ft/lb	7.2	4.8	--	--	--	4.8	12.0
Surface area sq m/kg	1.5	1.0	--	--	--	1.0	2.5

[1] Saffil (Imperial Chemical Industries, Ltd.).
[2] AB–312 (3M Co.).
[3] AC–02 (3M Co.).
[4] Kaowool (Babcock and Wilcox).
[5] Refrasil (Hitco).
[6] ZS–11 (3M Co.).
[7] Saffil (Imperial Chemical Industries, Ltd.).
[8] At 1,800° F (1,255 K) mean.
[9] At 2,000° F (1,366 K).

Source: Materials Engineering, June 1975.

The Bureau of Mines has developed, at its Boulder City, Nev., Metallurgy Research Laboratory, a new high-strength, corrosion-resistant material composed of asbestos fiber reinforcing silica flour bonded together with plasticized sulfur. It is suitable for handling corrosive liquids such as sewage, acid leach solutions, mine waste water, and salt solutions.

[7] Chemical Engineering. Japanese Developed Synthetic Membranes for Use in Chlor-Alkali Diaphragm Cells. V. 82, No. 13, June 23, 1975, p. 75.

[8] Houston, A.M., Ceramic Fibers Fight Heat in Difficult Environments. Materials Engineering, v. 81, No. 6, June 1975, pp. 33–35.

Barite

By Stanley K. Haines [1]

Production of barite increased 16% in 1975 to 1.29 million tons. Nevada produced 71% of the total, with 1975 production in that State increasing 20% over that of 1974. Imports of crude barite decreased 13% to 634,000 tons. The domestic and imported barite was ground and used primarily as a weighting material in oil- and gas-well drilling fluids. Sales of crushed and ground barite for all uses increased 10% to 1.8 million tons. Demand for barite in well drilling muds more than offset decreased demand for other uses.

Table 1.—Salient barite and barium-chemical statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Barite (Primary):					
Sold or used by producers	825	906	1,104	1,106	1,287
Value	$13,491	$14,883	$16,688	$16,822	$20,673
Imports for consumption	484	624	716	729	634
Value	$4,468	$5,648	$7,596	$8,680	$8,541
Crushed and ground sold or used	1,330	1,461	1,571	1,637	1,807
Value	$34,020	$45,590	$54,473	$64,394	$73,075
Barium chemicals sold by producers	83	66	62	56	43
Value	$15,488	$13,869	$13,899	$15,751	$15,556
World: Production	4,114	4,360	r 4,945	r 4,944	5,296

r Revised.

DOMESTIC PRODUCTION

Producers sold or used 1,287,000 tons of primary barite in 1975. Primary barite is defined as the first marketable product and includes crude barite, flotation concentrates, and other beneficiated material such as washer, jig, or magnetic-separation concentrates.

Barite was produced at 42 mines in 1975; 18 in Nevada, 12 in Missouri, 3 in Tennessee, 2 each in Arkansas and Georgia, and 1 each in Alaska, California, Idaho, Illinois, and Montana. Nevada was the leading State, with 71% of the total quantity and 53% of the total value. The other producing States were, in descending order of production, Missouri, Arkansas, Georgia, Tennessee, Idaho, Illinois, Montana, Alaska, and California.

The leading producers of domestic barite for use in well drilling were (in alphabetical order) Baroid Div., NL Industries, Inc., with mines in Arkansas, Missouri, Nevada, and Tennessee; Dresser Minerals Div., Dresser Industries, Inc., with mines in Missouri and Nevada; and Minerals Div., Milchem, Incorporated, with mines in Missouri and Nevada.

Barite for chemical, glass, and filler uses were sold or used by De Soto, Inc.; Dresser Minerals Div., Dresser Industries, Inc.; Industrial Chemical Div., FMC Corporation; IMCO Services; New Riverside Ochre Co.; De Lore Products, Industrial Chemicals Div., NL Industries, Inc.; Paga Mining Co.; Minerals, Pigments, and Metals Div., Pfizer Inc.; and Westemco, Inc.

Imported and/or domestic barite was ground at 42 plants in 11 States. Louisiana

[1] Physical scientist, Division of Nonmetallic Minerals.

and Texas had seven plants each. The concentration of grinding plants in these States is due to the availability of imported barite and the close proximity to major areas of high drilling activity. Other States with grinding plants were Missouri, with six operations; Nevada and Utah, five each; California, four; Arkansas, Georgia, and Tennessee, two each; and Illinois and Montana, one each.

Table 2.—Barite (primary) sold or used by producers in the United States, by State
(Thousand short tons and thousand dollars)

State	1974		1975	
	Quantity	Value	Quantity	Value
Alaska	20	400	2	30
California	4	W	1	W
Missouri	177	3,386	171	3,989
Nevada	761	8,115	916	11,006
Other States [1]	144	4,920	198	5,647
Total [2]	1,106	16,822	1,287	20,673

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Arkansas, Georgia, Idaho, Illinois, Montana (1975), and Tennessee.
[2] Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Barite used as a weighting agent in oil- and gas-well drilling fluids represented 90% of all crushed and ground barite produced in 1975. This use increased 14% owing to increased drilling activity. Total footage drilled increased from 153.2 million feet in 1974 to 178.5 million feet in 1975. Barite for use in the manufacture of barium chemicals and as a filler or extender both dropped 28%. Both are related to products that suffered declines from the economic conditions prevalent during most of 1975. Other uses increased 21%. These other uses were as filler in rubber and plastics; flux, oxidizer, and decolorizer in glass manufacture; and miscellaneous uses, including ballast for ships, heavy concrete aggregate, and unspecified industrial uses.

The data in table 3 are mainly for ground barite, but they also include the relatively small tonnage of crushed barite, which is used principally in the barium-chemical industry.

Barite is the principal raw material in the production of barium chemicals. The producers of barium chemicals in 1975 were J. T. Baker Chemical Co., Phillipsburg, N.J.; Barium & Chemicals, Inc., Steubenville, Ohio; Chemical Products Corp., Cartersville, Ga.; Industrial Chemical Div., FMC Corporation, Modesto, Calif.; The Great Western Sugar Company, Johnstown, Colo.; Hummel Chemical Co., Inc., South Plainfield, N.J.; Mallinckrodt Inc., St. Louis, Mo.; and Chemical Div., Sherwin-Williams Co., Coffeyville, Kans. Sherwin-Williams also produced lithopone.

Barium carbonate was the largest volume barium chemical produced and sold, with 49% of total production and 65% of total sales. It is used in the manufacture of television picture tubes, for scum control in brick and tile, in barium ferrite manufacture, and for many other purposes. Barium hydroxide is used in ceramic work, as an additive in oils and greases, and in sugar refining.

Table 3.—Crushed and ground barite sold, by use [1]

Use [2]	1973		1974		1975	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Barium chemicals [3]	108,693	7	r 100,253	6	71,788	4
Filler or extender:						
Paint	52,404	3	48,219	3	34,817	2
Rubber	W	--	W	--	W	--
Other filler	W	--	W	--	W	--
Well drilling	1,326,451	83	1,440,046	87	1,638,370	90
Other uses	104,722	7	70,252	4	85,221	4
Total	1,592,270	100	r 1,658,770	100	1,830,196	100

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes imported barite.
[2] Uses reported by producers of ground and crushed barite, except for barium chemicals.
[3] Quantities reported by consumers.

Table 4.—Barium chemicals produced and sold by producers in the United States in 1975 [1]

Barium chemical	Plants	Produced (short tons)	Sold by producers	
			Quantity (short tons)	Value
Barium carbonate	6	25,824	28,018	$6,160,759
Barium chloride	3	W	W	W
Barium hydroxide	1	W	W	W
Barium oxide	2	W	W	W
Black ash	2	W	W	W
Blanc fixe	1	W	W	W
Other barium chemicals	6	26,580	14,846	9,395,637
Total	[2] 8	52,404	42,864	15,556,396

W Withheld to avoid disclosing individual company confidential data; included with "Other barium chemicals."
[1] Only data reported by barium-chemical plants that consume barite are included.
[2] A plant producing more than one product is counted only once.

PRICES

Prices quoted in Engineering and Mining Journal increased for all classes except water-ground barite, 99.5% $BaSO_4$, 325 mesh. Prices listed in trade publications serve as a general guide but do not necessarily reflect actual transactions.

The average value per ton of crude barite was $16.06 in 1975, an increase of $0.85 per ton over the 1974 value. The average value per ton of crushed and ground barite increased 3% to $40.44 in 1975.

Table 5.—Barite price quotations in 1975

Item	Price per short ton
Chemical, filler, glass grades, f.o.b. shipping point, carload lots:	
Handpicked, 95% $BaSO_4$, not over 1% Fe	$40.00–$60.00
Magnetic or flotation, 96% $BaSO_4$, not over 0.5% Fe	45.00– 50.00
Water-ground, 99.5% $BaSO_4$, 325 mesh, 50-lb bags	60.00– 80.00
Drilling-mud-grade:	
Ground, 83%–93% $BaSO_4$, 3%–12% Fe, specific gravity 4.20–4.30, f.o.b. shipping point, carload lots	71.00– 78.00
Crude, imported, specific gravity 4.20–4.30, c.i.f. gulf ports	19.00– 28.00

Source: Engineering and Mining Journal. V. 176, No. 12, December 1975.

FOREIGN TRADE

Barite exports decreased in 1975. Japan was the major recipient of these exports. The barite, primarily ground material, was shipped principally from the following customs districts: Los Angeles, Calif., 65%; New Orleans, La., 15%; Detroit, Mich., 6%; Seattle, Wash., 6%; and Houston, Tex., 3%.

There was 634,000 tons of crude barite and 38,000 tons of ground barite imported in 1975. This represented a 13% decline in imports of crude material and an increase of almost 6% for ground barite. The principal sources were Peru, Ireland, and Mexico. Declared values per short ton of crude barite at foreign ports averaged as follows for these countries: Peru, $11.58; Ireland, $11.19; and Mexico, $12.60.

Crude barite, nearly all of drilling-mud grade, entered the United States through the following customs districts: New Orleans, 48%; Laredo, 20%; Galveston, 15%; Port Arthur, 12%; and Houston, El Paso, and San Francisco combined, 5%.

Import data also showed imports of crude witherite from the United Kingdom, and crushed or ground witherite from Japan and the Netherlands. However, these statistics are open to question because there has been no reported production of witherite since the Settlingstone mine in northern England was closed in 1969. These imports could be manufactured barium carbonate instead of natural barium carbonate (witherite).

Imports of barium chemicals were down 75% compared with those of 1974. All categories except barium nitrate showed significant decreases in quantity. The decline was the result of the general economic downturn in 1975, which caused major production decreases in barium-chemical-consuming industries. Inventory adjustments by domestic consumers also added to the lower import levels.

Table 6.—U.S. exports of natural barium sulfate and carbonate

Country	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Angola	4,389	$264	2,055	$145
Argentina	80	9	20	4
Australia	116	6	362	19
Brazil	416	28	3,162	196
Cameroon	1,202	129	--	--
Canada	41,539	1,242	8,768	600
Colombia	80	3	78	3
Costa Rica	--	--	48	2
El Salvador	--	--	83	9
Germany, West	--	--	89	4
Ghana	1,058	82	479	37
Guatemala	60	3	1,586	130
Indonesia	--	--	61	3
Israel	753	42	--	--
Japan	44	3	36,316	165
Korea, Republic of	--	--	27	1
Lebanon	--	--	93	4
Malagasy Republic	420	29	--	--
Mauritius	--	--	1,027	72
Mexico	263	14	54	6
Netherlands	--	--	101	4
New Zealand	350	30	335	92
Nicaragua	4,492	310	208	15
Niger	40	2	--	--
Pakistan	1,804	79	--	--
Panama	--	--	30	1
Peru	86	4	--	--
Philippines	1,310	74	129	10
Saudi Arabia	2,030	126	--	--
Singapore	--	--	20	3
South Africa, Republic of	512	26	287	23
Surinam	--	--	1,102	85
Taiwan	--	--	528	70
United Arab Emirates	--	--	150	139
United Kingdom	--	--	59	3
Venezuela	201	13	129	23
Total	61,245	2,518	57,386	1,868

Table 7.—U.S. exports of lithopone

Year	Quantity (short tons)	Value (thousands)
1973	986	$357
1974	1,185	967
1975	1,833	1,060

Table 8.—U.S. imports for consumption of barite, by country
(Thousand short tons and thousand dollars)

Country	1974		1975	
	Quantity	Value	Quantity	Value
Crude barite:				
Belgium-Luxembourg	(1)	1	--	--
Canada	34	389	47	541
Denmark	--	--	11	185
Germany, East	--	--	9	159
Greece	64	902	47	839
Ireland	230	2,696	107	1,197
Mexico	127	1,531	104	1,310
Morocco	41	842	47	1,286
Peru	233	2,319	261	3,022
United Arab Emirates	--	--	1	2
Total	729	8,680	634	8,541
Ground barite:				
Canada	(1)	4	3	307
Germany, West	(1)	17	--	--
Mexico	36	454	35	404
Peru	--	--	(1)	12
Total	36	475	38	723

[1] Less than ½ unit.

Table 9.—U.S. imports for consumption of barium chemicals

Year	Lithopone		Blanc fixe (precipitated barium sulfate)		Barium chloride		Barium hydroxide	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	84	$29	7,522	$1,631	10,774	$1,987	2,481	$800
1974	262	139	8,843	2,273	13,455	3,545	10,072	4,173
1975	15	6	5,443	2,047	1,199	358	2,595	1,492

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	691	$138	10,206	$1,603	1,022	$531
1974	455	151	8,719	1,723	1,577	1,029
1975	593	233	681	111	411	196

Table 10.—U.S. imports for consumption of crude, unground, and crushed or ground witherite

Year	Crude, unground		Crushed or ground	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	141	$19	4,470	$697
1974	3	1	3,432	709
1975	1	(1)	84	44

1 Less than ½ unit.

WORLD REVIEW

World barite production remained at a high level through 1975. Preliminary estimates indicate that the United States supplied 25% of the world total.

France.—A new company, Société Garrot-Chaillac, was formed to work the Rossignal barite deposit 31 miles southeast of Chateauroux. The deposit extends over an area of about 50 acres and averages about 40 to 43 feet in thickness. Reserves are estimated to be about 8.8 million tons. A plant was set up to produce 100,000 tons per year by flotation and an additional 20,000 tons per year by heavy media separation. Operations were due to start in late 1975.[2]

India.—The Government of India announced that effective January 14, 1976, all exports of barite will be channeled through the Government-owned Minerals and Metals Trading Corp. (MMTC). This step is designed to control exports and to obtain a higher unit value for this mineral. Exports of barite for the first 4 months of 1975 totaled 60,600 tons.

The Government has reportedly located a large deposit of barite with reserves of 15 million tons. The deposit is in Margarupeta in the State of Andhra Pradesh.

Other Countries.—Construction or modifications to jig and grinding plants were reported in Algeria, Australia, Indonesia, Iran, Ireland, and Thailand.

2 Industrial Minerals (London). No. 93, June 1975, pp. 9–10.

Table 11.—Barite: World production, by country

(Thousand short tons)

Country 1	1973	1974	1975 p
North America:			
Canada	102	86	e 96
Mexico	281	300	331
United States 2	1,104	1,106	1,287
South America:			
Argentina	32	34	e 33
Brazil	r 59	67	e 72
Chile	5	5	7
Colombia	2	3	e 3
Peru	367	r e 250	e 255
Europe:			
Austria	(3)	(3)	(3)
Czechoslovakia e	8	8	8
France	121	116	e 110
Germany, East e	34	34	34
Germany, West	360	329	273
Greece 4	87	103	118
Ireland	298	380	325
Italy	r 185	198	235
Poland e	55	60	59
Portugal	2	2	2
Romania e	128	128	128
Spain	r 136	115	e 110
U.S.S.R. e	r 350	360	380
United Kingdom	65	55	e 55
Yugoslavia	68	55	e 55
Africa:			
Algeria 5	78	58	75
Egypt	2	(3)	1
Kenya	1	(3)	(3)
Morocco	113	103	150
South Africa, Republic of	2	2	1
Swaziland	(3)	(3)	(3)
Tunisia	20	19	16

See footnotes at end of table.

Table 11.—Barite: World production, by country—Continued
(Thousand short tons)

Country [1]	1973	1974	1975 [p]
Asia:			
Afghanistan	[e] 5	[e] 10	[e] 6
Burma	17	[6] 17	17
China, People's Republic of [e]	182	[r] 220	275
India	[r] 130	154	188
Iran [7]	105	[e] 105	[e] 105
Japan	[r] 70	42	41
Korea, North [e]	132	132	132
Korea, Republic of	([3])	1	3
Pakistan	2	5	[e] 2
Philippines	4	--	4
Thailand	123	221	285
Turkey	[r] 99	53	11
Oceania: Australia	11	8	[e] 8
Total	[r] 4,945	4,944	5,296

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, Bulgaria and Southern Rhodesia also produce barite, but available information is inadequate to make reliable estimates of output levels.
[2] Sold or used by producers.
[3] Less than ½ unit.
[4] Barite concentrates.
[5] Ground barite.
[6] Year beginning Apr. 1, 1974.
[7] Year beginning March 21 of that stated.

Bauxite and Alumina

By Horace F. Kurtz [1]

The bauxite and alumina industries in 1975 were characterized by cutbacks in production rates, particularly in the Western Hemisphere, and postponements or cancellations of plans for expansion. The downturn, following 2 years of strong growth, reflected a general recession in Western countries and a much lower demand for aluminum, the principal end use of bauxite and alumina.

World bauxite production declined 4% to 74 million long tons in 1975. Production of alumina, the intermediate step between bauxite and aluminum production, fell 7% to 29 million short tons.

In the United States, bauxite and alumina production declined 9% and 25%, respectively. Imports of bauxite dropped sharply but still provided 86% of the bauxite used by domestic alumina producers. Imports provided 38% of the new supply of alumina.

Historical data, 1938–75, on bauxite production, imports, and consumption in the United States and world production are presented in table 2.

Legislation and Government Programs.—Jamaica-type metallurgical-grade bauxite in government stockpiles was authorized for sale during 1975, but none was sold. Surinam-type metallurgical-grade bauxite sold previously was shipped from government stockpiles.

[1] Industry economist, Division of Nonferrous Metals.

Table 1.—Salient bauxite statistics
(Thousand long tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Production, crude ore (dry equivalent)	1,988	1,812	1,879	1,949	1,772
Value	28,543	23,238	26,635	25,663	25,083
Exports (as shipped)	34	29	12	16	19
Imports for consumption [1]	12,634	11,976	12,778	14,308	10,782
Consumption (dry equivalent)	15,619	15,375	16,650	16,904	12,458
World: Production	61,143	63,921	r 69,244	r 76,810	73,939

r Revised.
[1] Excludes calcined bauxite imported into the Virgin Islands.

Bauxite production in the United States decreased 9% to 1.77 million long tons (dry equivalent) in 1975. Production was down 11% in Arkansas, which produced 87% of the total. The loss in Arkansas was partially offset by greater output of bauxite for uses other than alumina in Alabama. All of the bauxite mines were open pit operations except for the Mars Hill underground mine of Reynolds Mining Corp. in Saline County, Ark.

Table 2.—Bauxite statistics, 1938–75

(Thousand long tons)

Year	Domestic production [1] (dry basis)			Imports for consumption [2]		Domestic consumption [3] (dry basis)	World production
	Arkansas	Other States [4]	Total	Crude and dried	Calcined		
1938	294	17	311	456	--	710	3,808
1939	362	13	375	520	--	843	4,275
1940	428	11	439	630	--	983	4,321
1941	856	81	937	1,117	--	1,928	6,017
1942	2,460	142	2,602	884	--	2,821	8,226
1943	6,036	197	6,233	1,542	--	5,332	13,749
1944	2,695	129	2,824	556	--	3,460	6,849
1945	910	71	981	737	--	2,433	3,376
1946	1,050	54	1,104	852	--	1,889	4,291
1947	1,154	48	1,202	1,821	--	2,564	6,219
1948	1,395	62	1,457	2,488	--	2,725	8,227
1949	1,095	54	1,149	2,688	--	2,678	8,100
1950	1,307	28	1,335	2,516	9	3,325	8,038
1951	1,815	34	1,849	2,820	19	3,946	10,680
1952	1,604	63	1,667	3,462	31	4,228	12,549
1953	1,530	50	1,580	4,230	92	5,628	13,562
1954	1,949	46	1,995	4,988	99	6,428	15,833
1955	1,721	67	1,788	4,882	108	6,989	17,115
1956	1,669	75	1,744	5,670	149	7,751	18,069
1957	1,357	59	1,416	7,098	67	7,633	19,626
1958	1,258	53	1,311	7,915	30	7,034	20,410
1959	1,631	69	1,700	8,149	109	8,619	21,971
1960	1,932	66	1,998	8,739	119	8,883	26,037
1961	1,179	49	1,228	9,206	70	8,621	27,389
1962	1,270	99	1,369	10,575	120	10,577	29,129
1963	1,478	47	1,525	9,259	183	11,318	28,565
1964	1,562	39	1,601	10,352	189	12,546	31,586
1965	1,593	61	1,654	11,418	216	13,534	35,349
1966	1,718	78	1,796	11,740	204	14,084	38,589
1967	1,571	83	1,654	12,135	214	14,503	42,383
1968	1,582	83	1,665	11,816	207	14,097	43,968
1969	1,755	88	1,843	12,925	200	15,580	50,697
1970	1,869	213	2,082	13,574	256	15,673	56,610
1971	1,781	207	1,988	13,645	292	15,619	61,143
1972	1,634	178	1,812	12,600	247	15,375	63,921
1973	1,686	193	1,879	13,403	294	16,650	69,244
1974	1,731	218	1,949	15,069	304	16,904	76,810
1975	1,543	229	1,772	11,719	348	12,458	p 73,939

p Preliminary.
[1] Shipments 1938–39, production 1940–75.
[2] Includes imports for the U.S. stockpile 1947–65 and imports into the U.S. Virgin Islands 1967–75.
[3] Apparent consumption 1938–40, actual consumption 1941–75. Includes consumption by Canadian abrasives industry.
[4] Alabama and Georgia, all years; Virginia, 1940–46; Mississippi, 1942; Oregon and Washington, 1970.

NOTE.—Data for 1910–38 on domestic production, imports, exports, and apparent consumption of bauxite were published in Minerals Yearbook, 1939.

DOMESTIC PRODUCTION

In Arkansas, Aluminum Co. of America (Alcoa), American Cyanamid Co., and Reynolds produced bauxite in Saline County. Reynolds also mined in Pulaski County. Both Alcoa and Reynolds delivered crude bauxite to their own alumina plants nearby. Bauxite processing plants were operated by American Cyanamid, Porocel Corp., and Stauffer Chemical Co.

In Alabama, bauxite was mined in the Eufaula district, Barbour and Henry Counties, by Abbeville Lime Co., A. P. Green Refractories Co., Harbison-Walker Refractories Co., and Wilson-Snead Mining Co. Drying or calcining plants were operated by A. P. Green, Harbison-Walker, and Wilson-Snead.

American Cyanamid and C-E Minerals, Inc., mined bauxite in Sumter County, Ga., and operated processing plants at Andersonville, Ga.

Reduced demand for aluminum resulted in severe cutbacks in operations at both primary aluminum plants and alumina plants in 1975. Production of alumina and aluminum oxide products (excluding aluminates) at the eight alumina plants in the United States and the one plant in the U.S. Virgin Islands decreased 25% to 5,847,000 short tons (5,660,000 tons calcined alumina equivalent) in 1975. The total production included 5,223,000 tons of calcined alumina, 530,000 tons of commercial alumina trihydrate, and 94,000 tons of tabular, activated, and other alumina. The production of all forms of alumina declined.

Alumina shipments by producers totaled 5,860,000 tons (5,671,000 tons calcined equivalent) and were valued at $697 million. Calcined alumina shipments to primary aluminum plants totaled 5,019,000 tons, or 89% of the calcined equivalent of total shipments. The chemical industry, including producers of aluminum fluoride fluxes for aluminum plants, received over half of the remaining tonnage, largely as hydrate. Other shipments of alumina went mainly to producers of abrasives, ceramics, and refractories.

Table 3.—Mine production of bauxite and shipments from mines and processing plants to consumers in the United States
(Thousand long tons and thousand dollars)

State and year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dry equivalent	Value [1]	As shipped	Dry equivalent	Value [1]
Alabama and Georgia:						
1971	261	207	3,564	r 113	r 145	r 4,072
1972	227	178	2,228	r 131	r 173	r 4,533
1973	247	193	2,751	r 171	r 225	r 5,731
1974	272	218	2,066	r 154	r 211	r 6,124
1975	302	229	2,127	175	236	5,622
Arkansas:						
1971	2,157	1,781	24,979	r 2,067	r 1,818	r 26,483
1972	1,973	1,634	21,010	r 2,127	1,844	r 25,085
1973	2,040	1,686	23,884	r 2,076	r 1,780	r 26,708
1974	2,098	1,731	23,597	2,130	r 1,810	r 26,737
1975	1,862	1,543	22,956	1,883	1,599	25,486
Total United States: [2]						
1971	2,419	1,988	28,543	r 2,179	r 1,963	r 30,555
1972	2,200	1,812	23,238	r 2,258	r 2,017	r 29,618
1973	2,287	1,879	26,635	r 2,246	r 2,005	r 32,439
1974	2,370	1,949	25,663	r 2,284	r 2,021	r 32,862
1975	2,164	1,772	25,083	2,058	1,836	31,108

r Revised.
[1] Computed from selling prices and values assigned by producers and from estimates of the Bureau of Mines.
[2] Data may not add to totals shown because of independent rounding.

Table 4.—Recovery of dried, calcined, and activated bauxite in the United States
(Thousand long tons)

Year	Crude ore treated	Total processed bauxite recovered [1]	
		As recovered	Dry equivalent
1971	444	250	357
1972	399	210	319
1973	338	169	287
1974	348	177	279
1975	355	179	282

[1] Dried, calcined, and activated bauxite.

Table 5.—Percent of domestic bauxite shipments, by silica content

SiO_2 (Percent)	1971	1972	1973	1974	1975
Less than 8	4	6	6	2	4
From 8 to 15	65	64	61	72	62
More than 15	31	30	33	26	34

Table 6.—Production and shipments of alumina in the United States

(Thousand short tons)

Year	Calcined alumina	Other alumina [1]	Total: As produced or shipped [2]	Total: Calcined equivalent
Production: [3]				
1971	6,545	668	7,213	7,002
1972	6,235	741	6,976	6,739
1973	6,834	734	7,568	7,344
1974	7,059	753	7,812	7,589
1975	5,223	624	5,847	5,660
Shipments:				
1971	6,525	659	7,184	6,975
1972	6,222	745	6,968	6,730
1973	6,822	738	7,561	7,335
1974	7,051	745	7,796	7,575
1975	5,232	628	5,860	5,671

[1] Trihydrate, activated, tabular, and other aluminas. Excludes calcium and sodium aluminates.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes only the end product if one type of alumina was produced and used to make another type of alumina.

Table 7.—Capacities of domestic alumina plants, December 31, 1975 [1]

(Thousand short tons per year)

Company and plant	Capacity
Aluminum Co. of America:	
Bauxite, Ark	375
Mobile, Ala	990
Point Comfort, Tex	1,335
Total	2,700
Martin Marietta Aluminum, Inc.:	
St. Croix, V.I	455
Kaiser Aluminum & Chemical Corp.:	
Baton Rouge, La	1,025
Gramercy, La	800
Total	1,825
Ormet Corp.: Burnside, La	600
Reynolds Metals Co.:	
Hurricane Creek, Ark	840
Corpus Christi, Tex	1,385
Total	2,225
Grand total	7,805

[1] Capacity may vary depending upon the bauxite used.

CONSUMPTION AND USES

Bauxite consumption in the United States (including the U.S. Virgin Islands) dropped 26%, or about 4.4 million long dry tons, from the record high level of 1974. The large decrease was attributed to the recession in 1975, and consumption was down in all of the major uses of bauxite. About 86% of the bauxite consumed during the year was provided from foreign countries.

The production of alumina in various forms required 92% of the total bauxite consumed in 1975. An average of 2.03 long dry tons of bauxite was used to produce 1 short ton (calcined basis) of alumina. The two alumina plants in Arkansas used mainly bauxite mined in Arkansas, and the other seven alumina plants used only imported ore.

Bauxite use by the refractory industry declined 24% to 410,000 tons (dry weight basis). Nearly all of this bauxite was used in the calcined form, which weighs about 65% of the dry equivalent weight. Imports comprised 77% of the bauxite used in refractories. Refractory producers reported receipts of about 95,000 tons (dry basis) of domestic bauxite and 400,000 tons of imported ore. An estimated 85% of the foreign bauxite came from Guyana, and nearly all of the remainder came from Surinam.

Five companies consumed calcined bauxite in manufacturing artificial abrasives. All of the receipts of bauxite by these companies in 1975 came from Surinam. Total consumption by the abrasives industry dropped 35% from that of 1974. Data on consumption by this industry include bauxite fused and crushed in Canada because much of this material is made into abrasive wheels and coated products in the United States. About 10% to 15% of this material is used for nonabrasive applications, principally refractories.

Bauxite consumption in the chemicals industry decreased 15% in 1975. The United States, Guyana, and Surinam continued to be the sources of bauxite for this industry. The production of commercial aluminum sulfate in the United States, according to the Bureau of the Census,[2] decreased from 1.28 million short tons in 1974 to 1.06 million tons in 1975.

Other consumers of bauxite, in descending order of magnitude, included the cement, oil and gas, and steel and ferroalloys industries, and municipal waterworks.

Thirty-one primary aluminum plants in the United States consumed 7,508,000 short tons of calcined alumina, 20% less than the 9,384,000 tons consumed in 1974. Alumina consumption data for other uses were not available. A significant quantity was used to make aluminum fluoride and synthetic cryolite, which are also used in the production of primary aluminum.

[2] Bureau of the Census, U.S. Department of Commerce. Current Industrial Reports, Inorganic Chemicals. Series M28A (75)-12, February 1976, p. 2.

Table 8.—Bauxite consumed in the United States, by industry
(Thousand long tons, dry equivalent)

Year and industry	Domestic	Foreign	Total [1]
1974:			
Alumina	1,720	13,924	15,644
Abrasive [2]	--	295	295
Chemical	[3]175	[3]250	341
Refractory	93	446	539
Other	W	W	85
Total [1 2]	1,989	14,915	16,904
1975:			
Alumina	1,531	9,966	11,497
Abrasive [2]	--	193	193
Chemical	[3]176	[3]182	291
Refractory	94	316	410
Other	W	W	67
Total [2]	1,801	10,657	12,458

W Withheld to avoid disclosing individual company confidential data; included with "Chemical."
[1] Data may not add to totals shown because of independent rounding.
[2] Includes consumption by Canadian abrasive industry.
[3] Includes other uses.

Table 9.—Crude and processed bauxite consumed in the United States
(Thousand long tons, dry equivalent)

Type	Domestic origin	Foreign origin	Total [1]
1974:			
Crude and dried	1,743	14,172	15,914
Calcined and activated	246	743	989
Total [1]	1,989	14,915	16,904
1975:			
Crude and dried	1,546	10,142	11,688
Calcined and activated	255	515	770
Total	1,801	10,657	12,458

[1] Data may not add to totals shown because of independent rounding.

Table 10.—Production and shipments of selected aluminum salts in the United States, in 1974

(Thousand short tons and thousand dollars)

Item	Number of producing plants	Production	Total shipments including interplant transfers: Quantity	Total shipments including interplant transfers: Value
Aluminum sulfate:				
Commercial (17% Al_2O_3)	68	1,283	1,163	60,481
Municipal (17% Al_2O_3)	2	4	XX	XX
Iron-free (17% Al_2O_3)	21	232	220	7,672
Aluminum chloride:				
Liquid (32°Be)	5	W	W	W
Crystal (32°Be)				
Anhydrous (100% $AlCl_3$)	5	37	36	17,931
Aluminum fluoride, technical	4	W	W	W
Aluminum hydroxide, trihydrate (100% $Al_2O_3 \cdot 3H_2O$)	6	533	496	54,436
Other inorganic aluminum compounds [1]	XX	XX	XX	32,158

W Withheld to avoid disclosing individual company confidential data. XX Not applicable.

[1] Includes sodium aluminate, light aluminum hydroxide, cryolite, and alums.

Source: Data are based upon Bureau of the Census report Form MA-28E.1, Annual Report on Shipments and Production of Inorganic Chemicals.

STOCKS

Total inventories of bauxite in the United States rose by 6% to 20.8 million long dry tons during 1975. The overall increase was largely the result of a buildup of stocks at alumina plants. Refractory producers also increased stocks, but abrasive producers reduced inventories significantly. Government stockpiles were lowered by 86,000 tons, all of which was Surinam-type bauxite.

The Government stockpile at the end of 1975 included 4,638,000 tons of Jamaica-type bauxite, which was the total stockpile objective, 9,789,000 tons of Jamaica-type, Surinam-type, and refractory-grade bauxite classified as uncommitted excess (unsold), and 639,000 tons committed for disposal.

Inventories of alumina and related products at plants producing alumina and primary aluminum increased 103,000 short tons to 1,458,000 tons. The Government held no stocks of alumina except in the form of abrasive grain and crude fused aluminum oxide. These stockpiles were reduced 5% to 338,000 short tons.

Table 11.—Stocks of bauxite in the United States [1]

(Thousand long tons, dry equivalent)

Sector	Dec. 31, 1974 r	Dec. 31, 1975
Producers and processors	534	484
Consumers [2]	3,982	5,248
Government	15,152	15,066
Total	[3] 19,669	20,798

r Revised.

[1] Domestic and foreign bauxite; crude, dried, calcined, activated; all grades.

[2] Includes bauxite stockpiled by the U.S. Government during World War II and purchased by Reynolds Metals Co.

[3] Data do not add to total shown because of independent rounding.

Table 12.—Stocks of alumina in the United States [1]

(Thousand short tons)

Sector	Dec. 31, 1974	Dec. 31, 1975
Producers	230	217
Primary aluminum plants	1,125	1,241
Total	1,355	1,458

[1] Excludes consumers' stocks other than those at primary aluminum plants.

PRICES

Prices on most of the bauxite and alumina produced throughout the world are not quoted because the large tonnages used by the aluminum industry are usually obtained from affiliated companies or purchased under long-term negotiated contracts.

Bureau of Mines estimates of the value of domestic production were based on incomplete data supplied by producers. The Bureau's estimated average value of crude domestic bauxite shipments in 1975, f.o.b. mine or plant, was $11.50 per long ton. The average value of shipments of domestic calcined bauxite was estimated at $43.80 per ton. Bauxite values among producers varied widely because of differences in grade.

The average value of imported dried or partially dried bauxite consumed at alumina plants in the United States and the Virgin Islands in 1975 was estimated from reports to the Bureau of Mines at $29.85 per long dry ton, compared with $23.21 in 1974. Engineering and Mining Journal published the following prices on supercalcined refractory-grade bauxite imported from Guyana, car lots, per metric ton:

	January-March	April-October	November-December
F.o.b. Baltimore, Md	$104.15	$105.61	$105.31
F.o.b Mobile, Ala	104.23	105.87	105.57

The average value of domestic calcined alumina shipments as determined from producers' reports was $116.35 per short ton. Shipments of alumina trihydrate averaged $101.38 per ton. The average value of imported alumina (including small quantities of hydrate), as reported by the Bureau of the Census, was $105.50 per ton at port of shipment. Exports of alumina from the United States and the Virgin Islands averaged $130.23 per ton.

Table 13.—Market quotations on alumina and aluminum compounds
(In bags, carlots, freight equalized)

Compound		Jan. 3, 1975	Jan. 2, 1976
Alumina, calcined	per pound	$0.063–$0.069	$0.08
Alumina, hydrated, heavy	do	.0553	.06
Alumina, activated, granular, works	do	.1365	.1365
Alumina sulfate, commercial, ground (17% Al_2O_3)	per ton	99.00	111.00
Aluminum sulfate, iron-free dry (17% Al_2O_3)	do	115.60	140.00

Source: Chemical Marketing Reporter.

Table 14.—Average value of U.S. imports of crude and dried bauxite in 1975[1]
(Per long ton)

Country	Port of shipment (f.a.s.)	Delivered to U.S. ports (c.i.f.)
Australia	$8.79	$17.57
Dominican Republic	18.84	21.74
Guinea	13.82	20.95
Guyana	18.88	33.19
Haiti	22.30	24.47
Jamaica	22.50	25.18
Surinam	21.44	28.56
Other	10.73	16.42
Weighted average	20.67	24.91

[1] Excludes bauxite imported into the U.S. Virgin Islands.

Source: Based on data reported to U.S. Customs Service and compiled by the Bureau of the Census, U.S. Department of Commerce.

FOREIGN TRADE

Exports from the United States classified as "bauxite and concentrates of aluminum excluding alumina" totaled 19,000 long tons in 1975 and were valued at $1.65 million. Virtually all of these exports went to either Canada or Mexico.

Alumina exports increased 4% to 766,000 short tons, including 24,000 tons of aluminum hydroxide. Most of the exports were shipped from domestic alumina plants to affiliated aluminum plants in Canada, Ghana, Mexico, Venezuela, and Norway. An additional 263,000 tons was exported from the alumina plant in the U.S. Virgin Islands to the U.S.S.R., Norway, and Yugoslavia.

Annual aluminum sulfate exports increased to 48,000 short tons, valued at $2.9 million. Venezuela received 36,000 tons, and Canada received 5,000 tons. Exports of artificial corundum or fused aluminum oxide fell to 27,000 tons, valued at $13.6 million. Canada received the largest quantity among 49 recipient countries. Exports classified as "other aluminum compounds" declined to 43,000 tons, valued at $16.3 million. Much of this tonnage was believed to be aluminum fluoride and synthetic cryolite shipped to other countries for use as a flux in making primary aluminum. About 10,000 tons was shipped to Australia, 8,000 tons to Ghana, and 6,000 tons each to Surinam and Bahrain.

No duties were imposed on imports of bauxite, alumina, or aluminum hydroxide in 1975. All duties on these commodities were suspended in 1971.

Imports of crude, partially dried, and dried bauxite decreased 25% to 10.8 million long tons in 1975, reflecting a sharply reduced level of operations at domestic alumina plants. Receipts from all major import sources except Guinea declined. Half of the imports came from Jamaica, the largest source of bauxite for plants on the U.S. mainland since 1957. Surinam and Guinea each provided 17%, and the Dominican Republic and Haiti provided most of the remainder. An additional 939,000 tons of bauxite was imported into the U.S. Virgin Islands from Guinea and Guyana.

Imports of calcined bauxite into the United States increased to a record high level of 348,000 long calcined tons. Most of this tonnage was refractory-grade bauxite from Guyana. Additional calcined bauxite was imported into Canada from Surinam for manufacture into crude fused aluminum oxide, much of which was subsequently used in abrasive and refractory products in the United States.

Alumina imports, including small quantities of aluminum hydroxide, declined 3%. However, the proportion of total new supply of alumina (imports plus domestic production) provided by imports increased to 38%. Shipments from Australia accounted for 61% of the total imports, Jamaica provided 22%, and Surinam provided 14%.

Table 15.—U.S. exports of alumina,[1] by country
(Thousand short tons and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	1	283	5	1,098	2	896
Canada	328	25,299	266	25,336	217	30,350
France	2	627	2	672	2	556
Germany, West	11	1,518	5	2,103	4	2,565
Ghana	133	8,749	241	15,542	156	15,112
Italy	3	754	4	1,147	(2)	228
Japan	6	6,910	8	5,931	4	4,329
Mexico	101	7,442	128	11,121	131	16,483
Norway	--	--	--	--	73	7,543
Poland	20	1,180	(2)	18	(2)	21
Sweden	66	3,892	6	888	1	442
U.S.S.R	48	2,800	1	473	55	4,272
United Kingdom	4	1,878	5	1,998	4	2,181
Venezuela	33	2,633	54	5,082	104	9,812
Yugoslavia	3	735	(2)	16	(2)	47
Other	6	2,378	13	5,900	13	6,944
Total	765	67,078	738	77,325	766	101,781

[1] Includes exports of aluminum hydroxide: 1973—26,000 short tons, 1974—28,000 short tons, 1975—24,000 short tons.
[2] Less than ½ unit.

NOTE.—Excludes alumina exported from the U.S. Virgin Islands to foreign countries: 1973—Norway 157,000 tons (revised), the U.S.S.R. 126,000 tons; 1974—Norway 191,000 tons (revised), the U.S.S.R. 93,000 tons (revised); 1975—Norway 91,000 tons, the U.S.S.R. 103,000 tons, Yugoslavia 69,000 tons

Table 16.—U.S. imports for consumption of bauxite (crude and dried), by country
(Thousand long tons)

Country	1973	1974	1975
Australia	359	--	93
Dominican Republic	1,101	1,283	934
Greece	45	--	26
Guinea	164	1,256	1,835
Guyana	483	606	119
Haiti	[1]696	[1]586	495
Jamaica [1]	7,273	7,766	5,396
Sierra Leone	--	--	27
Surinam	2,651	2,811	1,857
Other	6	--	(2)
Total	12,778	14,308	10,782

[1] Dry equivalent of shipments to the United States.
[2] Less than ½ unit.

NOTE.—Excludes bauxite imported into the U.S. Virgin Islands from foreign countries: 1973—Australia 162,000 tons, Guyana 463,000 tons; 1974—Australia 73,000 tons, Guinea 414,000 tons, Guyana 143,000 tons, Sierra Leone 23,000 tons, Surinam 96,000 tons, Western Portuguese Africa 12,000 tons; 1975—Trinidad and Tobago 18,000 tons, Guyana 158,000 tons, Guinea 763,000 tons.

Table 17.—U.S. imports for consumption of bauxite (calcined), by country
(Thousand long tons and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
China, People's Republic of	--	--	1	31	14	350
Guyana	247	13,300	252	17,433	255	22,585
Surinam	36	1,843	50	2,153	64	2,291
Trinidad and Tobago	--	--	--	--	[1]15	1,463
Other	11	608	1	115	(2)	3
Total	294	15,751	304	19,732	348	26,692

[1] Shipments probably originated in Guyana or Surinam.
[2] Less than ½ unit.

Table 18.—U.S. imports for consumption of alumina,[1] by country

(Thousand short tons and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	1,970	118,529	2,202	154,376	2,154	201,748
Canada	21	2,489	20	2,322	21	3,289
Finland	(2)	8	4	1,798	--	--
France	1	924	9	9,554	11	14,563
Germany, West	3	1,075	6	2,605	4	2,126
Guinea	22	1,294	--	--	--	--
Guyana	33	1,936	10	609	22	1,651
Italy	--	--	--	--	29	2,673
Jamaica	904	57,768	902	69,241	779	96,609
Japan	73	5,077	(2)	55	(2)	22
Surinam	380	22,008	473	29,489	487	46,969
Other	(2)	180	1	568	(2)	389
Total	3,407	211,288	3,627	270,617	3,507	370,039

[1] Includes small quantities of aluminum hydroxide.
[2] Less than ½ unit.

NOTE.—Excludes shipments from the U.S. Virgin Islands to the United States: 1973—23,000 short tons ($1,686,505), 1974—83,000 short tons ($9,210,133), 1975—131,000 short tons ($16,409,676).

WORLD REVIEW

World bauxite production was estimated at nearly 74 million long tons, a decline of about 4% from 1974. Australia, Jamaica, and Guinea, the three largest producers, accounted for 56% of the 1975 total. The 11-member International Bauxite Association, which includes these three countries and the Dominican Republic, Ghana, Guyana, Haiti, Indonesia, Sierra Leone, Surinam, and Yugoslavia, produced 74% of the total. Production declined in half of the bauxite-producing countries. Jamaica and Surinam showed the largest decreases in production, while Guinea made the most significant increase.

World alumina production declined 7% to 29 million short tons in 1975. Most of the decline occurred in North America, where total output dropped 23%. The United States and Australia each produced 19% of the world total.

Table 19.—Bauxite: World production, by country

(Thousand long tons)

Country [1]	1973	1974	1975 p
North America:			
Dominican Republic [2] [3]	1,127	1,190	742
Haiti [4]	731	649	514
Jamaica [5]	13,385	15,086	11,388
United States [2]	1,879	1,949	1,772
South America:			
Brazil	r 836	886	886
Guyana [2]	3,224	r e 3,200	e 3,200
Surinam	6,998	r e 6,600	e 4,850
Europe:			
France	3,084	2,721	2,487
Germany, West	2	1	1
Greece	2,705	2,739	3,193
Hungary	2,559	2,707	2,845
Italy	49	31	24
Romania e	340	340	340
Spain	8	8	9
U.S.S.R. e [6]	4,200	4,200	4,300
Yugoslavia	2,133	2,333	2,270
Africa:			
Ghana	305	357	314
Guinea e	3,000	6,500	9,000
Mozambique	r 5	2	e 2
Sierra Leone	r 652	661	e 640
Asia:			
China, People's Republic of e [7]	r 750	r 950	950
India	r 1,272	1,095	1,250
Indonesia	1,210	1,270	977
Malaysia (West Malaysia)	1,125	933	692
Pakistan	(8)	(8)	e (8)
Turkey	347	654	621
Oceania: Australia	17,318	19,748	20,672
Total	r 69,244	76,810	73,939

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Southern Rhodesia may have continued to produce bauxite during the period covered by this table; however, no information on bauxite mining activities, if any, has been available since 1965.

[2] Dry bauxite equivalent of crude ore.

[3] Shipments.

[4] Dry bauxite equivalent of ore processed by drying plant.

[5] Bauxite processed for conversion to alumina in Jamaica plus exports of kiln-dried ore.

[6] Excludes materials other than bauxite used for production of alumina, estimated as follows in thousand long tons: Nepheline syenite (25% to 30% alumina), 1973—r 1,180, 1974—r 1,280, 1975—1,280; alunite ore (16% to 18% alumina): 1973—r 390, 1974—r 390, 1975—390.

[7] Diasporic bauxite; includes an estimated 160,000 long tons annually of production for refractory applications.

[8] Less than ½ unit.

Table 20.—Alumina: World production, by country

(Thousand short tons)

Country [1]	1973	1974	1975 p
North America:			
Canada	1,250	1,394	e 1,180
Jamaica	2,764	3,165	2,489
United States	7,344	7,589	5,660
South America:			
Brazil	255	r e 240	e 260
Guyana	285	354	343
Surinam	1,575	r e 1,300	e 1,260
Europe:			
Czechoslovakia e	110	110	110
France	r 1,226	1,229	1,206
Germany, East	52	53	e 55
Germany, West	998	1,441	e 1,400
Greece	519	545	506
Hungary	722	762	e 780
Italy	r 536	e 800	e 900
Romania e	310	410	410
United Kingdom	107	104	e 100
U.S.S.R. e	2,600	2,600	3,100
Yugoslavia	303	301	e 310
Africa: Guinea	667	733	709
Asia:			
China, People's Republic of e	330	r 440	440
India e	346	r 290	374
Japan	2,190	1,985	1,725
Taiwan	e 60	50	35
Turkey [2]	68	140	e 175
Oceania: Australia	r 4,507	5,398	5,652
Total	r 29,124	31,433	29,179

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Austria produces alumina (fused aluminum oxide), but output is used entirely for abrasives production. Production was as follows in short tons: 1973—31,110, 1974—not available, 1975—not available.

[2] The U.S.S.R. imports from Turkey; actual output may have been somewhat larger to provide raw material for an aluminum smelter due to begin operation in 1975.

Table 21.—World producers of alumina

(Thousand short tons)

Country, company, and plant location	Capacity yearend 1975	Ownership
NORTH AMERICA		
Canada: Alcan Smelters and Chemicals, Ltd., Arvida, Quebec.	1,387	Alcan Aluminium Ltd. 100%.
Jamaica:		
Alcan Jamaica Ltd.:		Alcan Aluminium Ltd. 100%.
Ewarton, St. Catherine	624	
Kirkvine, Manchester	615	
Alcoa Minerals of Jamaica, Inc., Woodside, Clarendon.	600	Aluminum Co. of America (Alcoa) 100%.
Alumina Partners of Jamaica, Ltd., Nain, St. Elizabeth.	1,300	Reynolds Metals Co. 36.5%, Anaconda Aluminum Co. 27%, Kaiser Aluminum & Chemical Corp. 36.5%.
Revere Jamaica Alumina, Ltd., Maggotty, St. Elizabeth.	220	Revere Copper & Brass Inc. 100%.
Total Jamaica	3,359	
United States (see table 7)	7,805	
Total North America	12,551	
SOUTH AMERICA		
Brazil:		
Alcan Alumínio do Brasil S.A., Saramenha, Minas Gerais.	100	Alcan Aluminium Ltd. 100%.
Cia. Brasileira de Alumínio, S.A., Sorocaba, São Paulo.	110	Industria Votorantim, Ltd. 80%, Government, 20%.
Cia. Mineira de Alumínio, Poços de Caldas, Minas Gerais.	155	Alcoa 50%, Hanna Mining Co. 23.5%, Brazilian interests 26.5%.
Total Brazil	365	

Table 21.—World producers of alumina—Continued
(Thousand short tons)

Country, company, and plant location	Capacity yearend 1975	Ownership
SOUTH AMERICA—Continued		
Guyana: Guyana Bauxite Co. Ltd., MacKenzie	390	Government 100%.
Surinam: Surinam Aluminum Co., Paranam	1,490	Alcoa 100%.
Total South America	2,245	
EUROPE		
Czechoslovakia: Zair	110	Government 100%.
France: Pechiney Ugine Kuhlmann Group:		Self 100%.
Gardanne	805	
Salindres	290	
La Barasse	365	
Total France	1,460	
Germany, East: V.E.B., Lauta	70	Government 100%.
Germany, West:		
Aluminium Oxid Stade GmbH, Stade	661	Vereinigte Aluminium-Werke AG (VAW) 50%, Reynolds 50%.
Gebrueder Giulini GmbH, Ludwigshafen	165	Self 100%.
Martinswerke GmbH für Chemische und Metallurgische Produktion Bergheim.	385	Swiss Aluminium Ltd. (Alusuisse) 99.2%.
Vereinigte Aluminium-Werke AG:		Government 100%.
Lippenwerke, Lunen	474	
Nabrewerk, Schwandorf	231	
Total West Germany	1,916	
Greece: Aluminium de Grèce S.A., Distomon	551	Pechiney Ugine Kuhlmann Group (PUK) 73%, Government and private Greek interests 27%.
Hungary:		
Ajka I; Ajka II; Almasfuzito; Magyarovar	e 800	Government 100%.
Italy:		
Alumetal S.p.A., Porto Marghera	220	Government 94%, Montedison 6%.
Eurallumina S.p.A., Porto Vesme, Sardinia	794	Alsar S.p.A. 41.67%, Comalco Ltd. 20%, Metallgesellschaft A.G. 17.5%, Alumetal S.p.A. 20.83%.
Total Italy	1,014	
Romania:		Government 100%.
Oradea	275	
Tulcea	275	
Total Romania	550	
United Kingdom: The British Aluminium Co., Ltd., Burntisland.	110	Tube Investments, Ltd. 52%, Reynolds 48%.
U.S.S.R.:		
Achinsk; Dneprovsk; Kamensk-Uralsky; Kandalaksa; Kirovabad; Krasnoturinsk; Novo Kuznetsk; Pavlodar; Pikalevo; Sumgait; Volgograd; Volkhov-Tikhiun	e 3,500	Government 100%.
Yugoslavia:		Government 100%.
Titograd, Montenegro	220	
Kidricevo, Slovenia	154	
Mostar, Bosnia-Hercegovina	309	
Total Yugoslavia	683	
Total Europe	10,764	

See footnote at end of table.

Table 21.—World producers of alumina—Continued

(Thousand short tons)

Country, company, and plant location	Capacity yearend 1975	Ownership
AFRICA		
Guinea: Friguia, Kimbo	772	Frialco Co. 51%, Government 49% (Frialco: Noranda Mines, Ltd. 38.5%, PUK 36.5%, British Aluminium 10%, Alusuisse 10%, VAW 5%).
Total Africa	772	
ASIA		
China, People's Republic of, Nanting and other locations.	[e] 400	Government 100%.
India:		
Aluminium Corp. of India, Ltd., Jaykaynagar, West Bengal.	25	Self 100%.
Bharat Aluminium Co., Korba, Madhya Pradesh.	220	Government 100%.
Hindustan Aluminium Corp. Ltd., Renukoot, Uttar Predesh.	165	Birla and Indian interests 73%, Kaiser 27%.
Indian Aluminium Co. Ltd.:		Alcan 55%, Indian interests 45%.
Muri, Bihar	85	
Belgaum, Mysore	175	
Madras Aluminium Co. Ltd., Mettur, Tamil Nadu.	55	Madras State Government 73%, Montedison 27%.
Total India	725	
Japan:		
Mitsui Alumina Corp., Wakamatsu	220	Mitsui group 98.5%, other Japanese interests 1.5%.
Nippon Light Metal Co. Ltd.:		Alcan 50%, Japanese interests 50%.
Shimizu	595	
Tomakomai	367	
Showa Denko K.K., Yokohama	683	Self 100%.
Sumitomo Chemical Co., Ltd., Kikumoto	844	Self 100%.
Total Japan	2,709	
Taiwan: Taiwan Aluminium Corp., Kaohsiung	84	Government 100%.
Turkey: Seydisehir	220	Government 100%.
Total Asia	4,138	
OCEANIA		
Australia:		
Alcoa of Australia (W.A.) N.L.:		Alcoa 51%, Australian interests 49%.
Kwinana, Western Australia	1,430	
Pinjarra, Western Australia	2,210	
Nabalco Pty. Ltd. Gove, Northern Territory	1,100	Alusuisse 70%, Gove Alumina Ltd. 30%.
Queensland Alumina Ltd., Gladstone, Queensland.	2,645	Kaiser 32.3%, Alcan 21.4%, Howmet Corp. 20%, Comalco 13.8%, Conzinc Riotinto of Australia, Ltd. 12.5% (Comalco: Conzinc Riotinto of Australia 45%, Kaiser 45%, public 10%).
Total Oceania	7,385	
Total World	37,855	

[e] Estimate.

Australia.—Alcoa of Australia (W.A.) N.L. operated its two alumina plants in Western Australia below rated capacity throughout most of 1975 because of decreased demand. Expansion of the Pinjarra refinery to an annual capacity of 2.2 million short tons was virtually completed. The new Huntley mine, about 3 miles north of the Del Park mine site, was opened and will provide additional bauxite for Pinjarra. A plant to produce 55,000 tons per year of hydrated alumina began production at the Kwinana refinery.

Comalco Ltd.'s bauxite production at Wiepa, Queensland, increased slightly to about 9.4 million long tons. Shipments of beneficiated bauxite declined 2% to 9.0 million tons, of which 52% went to the Gladstone alumina plant in Queensland, 14% to Japan, and 34% to Europe.

Nabalco Pty. Ltd. increased its bauxite production at Gove, Northern Territory, by 500,000 tons to 4.4 million tons in 1975. Production of alumina at the Gove refinery increased 14% to 1,028,000 short tons.

A bauxite-alumina project on the western side of the Cape York Peninsula was under consideration by Aurukun Associates, which consisted of a Texas-based company, Tipperary Corp. (40%), Billiton Aluminum Australia (40%), and Aluminium Pechiney Holdings Pty. (20%). Although the Queensland Parliament passed legislation permitting the consortium to proceed, objections were being raised by aborigines on whose reservation the bauxite occurs.

Brazil.—Mineração Rio do Norte S.A., an international consortium, announced plans to begin construction early in 1976 of the Trombetas bauxite mining project in the Amazon Basin. Construction costs were estimated at $280 million. Initial production at the rate of 3.3 million long tons per year was scheduled for early 1979, with plans for possible expansion to over 8 million tons per year. The consortium consisted of Cia. Vale do Rio Doce (CVRD) 40%, Alcan Aluminum Ltd. 19%, Cia. Brasileira de Alumínio (CBA) 11%, Reynolds Metals Co. 5%, Norsk Hydro A/S 5%, Ardal og Sunndal Verk (ASV) 5%, Instituto Nacional de Industria 5%, Rio Tinto Zinc Corp., Ltd. 5%, and two affiliates of the Royal Dutch Shell Group 5%. It was announced that Rio do Norte planned to set a reference price for bauxite every 4 years in order to guarantee a 13% return on investment for its shareholders.

Alumínio do Brasil (Albras) continued feasibility studies for an alumina-aluminum complex near Belém in Pará. The annual capacity of the alumina refinery was indefinite at yearend and may be reduced from the original announcement of 1.4 million short tons to about 700,000 tons. Power for the project would be supplied by a hydroelectric plant on the Tocantins River. Ownership of Albras consisted of CVRD and the Light Metals Smelters Association, a group of five Japanese aluminum companies. Alcan was reportedly interested in participating in the alumina sector of the project.

British Solomon Islands.—Mitsui Mining and Smelting Co. and Pacific Aluminum Pty. Ltd., a subsidiary of Conzinc Riotinto of Australia Ltd. (CRA), undertook a feasibility study for an alumina refinery on Rennell Island. Bauxite for the project would be supplied from the estimated 30-million-ton deposit on Rennell Island and a 28-million-ton deposit on Wagina Island. Ownership of the facility, which would have a first-stage production of 660,000 short tons per year, would include Mitsui, CRA, and the Government of the British Solomons.

Costa Rica.—Alcoa decided not to proceed with the development of bauxite mining and the construction of an alumina plant in Costa Rica. The Government and Alcoa agreed to terminate the contract, effective May 1976.

Dominican Republic.—The Government and Alcoa reached agreement on new bauxite levies, retroactive to April 1, 1974. The levies were set at 7.5% of the price realized on primary aluminum for 1974 and 7.7% for 1975 and 1976. In addition to the levy, a royalty of 56 cents per long ton will be assessed.

Germany, Federal Republic of.—Swiss Aluminium Ltd. (Alusuisse) was reported to have abandoned plans for a 330,000-short-ton-per-year bauxite refinery at Wilhelmshaven.

Ghana.—Bauxite Alumina Study Co. Ltd. (Bascol), composed of Kaiser Aluminum & Chemical Corp. and Aluminum Resources Development Co. (Ardeco), representing five Japanese aluminum companies, continued studies on the feasibility of a bauxite mining operation in the Kibi area and a large new alumina plant based on bauxite from Kibi. Ardeco reportedly withdrew from the project near yearend.

Greece.—Bauxite exports increased 9% to 1.6 million long tons in 1975. Export quotas set by the Government for 1976 totaled 3,132,000 tons compared with 3,105,000 tons set for 1975.

Bauxite Parnasse, S.A., continued a feasibility study for a 660,000-short-ton-per-year alumina refinery on the Gulf of Corinth. The proposed alumina production would be for export, and plant capacity eventually could be doubled. Aluterv of Hungary was to provide the technology for the plant. As envisioned at yearend, equity would be shared by Bauxite Parnasse 30%, Hellenic Industrial Development Bank 21%, and foreign participants 49%. Two U.S. companies, National Steel Corp. and Southwire Co., were expected to be the foreign participants. Financing for the $200 to $250 million plant reportedly would be arranged by Chase Manhattan Bank.

Guinea.—Guinea produced an estimated 9 million long tons of bauxite in 1975 and became the third largest bauxite producing country. Guinea Bauxite Co. (CBG), operators of the Boké project, produced over 5 million tons, and Friguia and Kindia Bauxite Office (OBK) each produced nearly 2 million tons.

CBG, owned by Halco (51%) and the Government of Guinea (49%), shipped high-grade bauxite from its plant and port at Kamsar largely to members of Halco. Halco was a consortium of aluminum producers consisting of Alcoa (27%), Alcan (27%), Martin Marietta Aluminum, Inc. (20%), Pechiney Ugine Kuhlmann Group (PUK) (10%), Vereinigte Aluminium-Werke AG (VAW) (10%), and Alumetal S.p.A. (6%).

Friguia, owned by Frialco Co. (51%) and the Government of Guinea (49%), mined bauxite for its alumina plant in Guinea. Frialco was another consortium consisting of Noranda Mines, Ltd. (38.5%), PUK (36.5%), The British Aluminium Co. Ltd. (10%), Alusuisse (10%), and VAW (5%). OBK mined bauxite at Débélé in the Kindia region entirely for export to the U.S.S.R.

The Government and Alusuisse joint venture, Société Minière et de Participations Guinée-Alusuisse (Somiga), continued to plan for mining the bauxite deposits at Tougué, estimated at 2 billion tons. Reported plans included construction of facilities to produce 8 million tons per year of bauxite and 1.2 million tons per year of alumina. The alumina plant would be constructed with Yugoslav assistance.

The Governments of Guinea, Egypt, Kuwait, Libya, Saudi Arabia, and the United Arab Emirates signed an agreement to form an aluminum company which would exploit bauxite deposits in the Ayékoyé area north of the CBG Boké concession. Reserves were estimated at 500 million tons with an alumina content of 51.6% to 59.6%. Reported plans for the new venture included a 9-million-ton-per-year bauxite mining operation and a 2-million-ton-per-year alumina refinery.

In January 1975, the Government adopted new tax legislation covering mineral ores exported from Guinea. The taxes on bauxite and alumina were indexed to the market price of aluminum ingot. The tax per ton of bauxite ranged from 0.5% of the price per ton of aluminum for the lowest grade ores to 0.75% for bauxite containing over 55% Al_2O_3. The rate per ton of alumina was 1.0% of the price per ton of aluminum.

Guyana.—Reynolds Guyana Mines Ltd. was nationalized January 1, 1975, and was operated during the year as Berbice Mines (Bermine). The operating rate was cut sharply because of the loss of Reynolds as a market for its metallurgical-grade bauxite. Marketing for Bermine bauxite was conducted by the Government-owned company, Guyana Bauxite Co. (Guybau), the only other bauxite producer in Guyana. The bauxite mining operations of Bermine and Guybau were described.[3]

Guybau production of metal-grade bauxite and calcined bauxite increased to 814,000 and 691,000 long tons, respectively, while its production of calcined alumina declined slightly to 329,000 short tons. A new kiln under construction was expected to add 150,000 tons per year of bauxite calcining capacity in 1976. As protection against fluctuating foreign exchange rates in its worldwide sales of calcined bauxite, Guybau announced a plan to set payment

[3] World Mining. Berbice Strips Bauxite With Scrapers, Loads With Draglines, Ships by Barge. V. 29, No. 2, February 1976, pp. 36–37.
———. Guybau Develops New Bauxite Mine, Increases Calcined Bauxite Capacity. V. 28, No. 11, October 1975, pp. 38–41.

prices using a composite currency unit based on the U.S. dollar, the pound sterling, the German deutsche mark, and the Swiss franc.

Haiti.—Reynolds Haitian Mines, Inc., and the Haitian Government reached a new agreement on bauxite taxes to be paid by Reynolds. The agreement included a bauxite production tax based on a rate of 7.5% of the price of primary aluminum for 1974 and 8.0% for 1975 and 1976, and an additional tax of 50 cents per long dry ton on bauxite exported. Reynolds also agreed to export at least 600,000 long dry tons per year.

Hungary.—The Rakhegy II bauxite mine in the Fejer district reached capacity production of 480,000 tons per year by yearend. Bauxite reserves reportedly were sufficient for production at this rate until 1986. Another new mine, the Deaki Puszta mine, with reserves estimated at 6.5 million tons, was scheduled to begin production in 1977.

India.—Discoveries of bauxite in India in the 1970's, particularly in the east coast States of Orissa and Andhra Pradesh, have greatly increased estimates of total Indian reserves and altered plans for establishment of new alumina plants. Evaluation of the reserves by State and Federal Government agencies continued through 1975. One estimate, prepared by the Government company, Metallurgical and Engineering Consultants, Ltd., classified reserves, in millions of long tons, as follows:

State	Measured or indicated	Inferred	Total
Orissa	126	473	599
Andhra Pradesh	50	356	406
Maharashtra	102	17	119
Madhya Pradesh	71	28	99
Bihar	24	21	45
Gujarat	21	22	43
Other	44	11	55
Total	438	928	1,366

Large additional discoveries of bauxite averaging 40% to 45% Al_2O_3 have been reported in Madhya Pradesh. The principal bauxite-producing States in 1975 were Bihar (454,000 tons), Madhya Pradesh (351,000 tons), and Maharashtra (237,000 tons).

As a result of the bauxite discoveries in Orissa and Andhra Pradesh, a new Government-owned alumina-aluminum complex was being considered for the Vishakapatnam area. The U.S.S.R. was reported to have abandoned plans for a 550,000-ton-per-year export-oriented alumina plant based on bauxite from Madhya Pradesh and to be considering a plant on the east coast. Reportedly, Iran was also considering an export-oriented plant on the east coast, as well as providing assistance for an alumina plant in Gujarat on the west coast.

Indonesia.—Indonesia became the 11th member of the International Bauxite Association in November 1975.

Ireland.—The owners of Alcan Ireland Ltd. postponed construction of a proposed alumina plant to produce 880,000 short tons per year on Aughinish Island. Alcan Ireland Ltd. was composed of Alcan (70%), Årdal og Sunndal Verk (20%), and Granges Essem AB (10%). The partners planned to review the proposal again in 1977.

Jamaica.—Bauxite and alumina was produced by affiliates of six North American aluminum companies. In addition to the bauxite produced to supply the five alumina plants on the island, Jamaican bauxite was exported, largely to plants in the United States, by Kaiser Bauxite Co., Reynolds Jamaica Mines Ltd., and Alcoa Minerals of Jamaica, Inc.

Decreased world demand forced the producers of bauxite and alumina to cut back production during 1975. Alumina Partners of Jamaica (Alpart) and Alcoa reduced the level of alumina production in February and June, respectively. In August, Revere Jamaica Alumina, Ltd., announced the closing of its alumina plant at Maggotty because of reduced aluminum production. Revere also announced in September that a decision to expand the Maggotty plant along with its aluminum smelter at Scottsboro, Ala., had been postponed by Revere and its proposed Japanese partners.

Operations were further curtailed by strikes and work slowdowns which affected all of the producers. Strikes at bauxite mines, beginning in late September and ending in November, disrupted the operations of Kaiser, Reynolds, and Alcan. Labor disputes at the Schwallenberg mines of Alcan resulted in the temporary closing of its alumina plant at Ewarton.

The Government and Reynolds reached agreement in principle on the terms of a partnership, similar to one announced in

1974 between the Government and Kaiser. Under the arrangement, Reynolds would sell to the Government a 51% interest in its mining assets and all of Reynolds' land holdings in Jamaica (approximately 66,000 acres) at book value, to be paid over 9 years. Reynolds would continue to manage the mining operations under a 7-year contract. Jamaica would lease bauxite land to the mining company sufficient to cover Reynolds' exports over a 40-year period. The agreement also was reported to include reductions in the rate of Reynolds' bauxite production levy provided Reynolds participated in a proposed alumina project of the Governments of Jamaica and Mexico.

Japan.—Nippon Light Metal Co. Ltd. announced plans to double its capacity for producing nonmetallurgical alumina at Shimizu to 220,000 tons per year.

Pakistan.—Construction of an alumina plant based on bauxite from Pakistan was being considered as a source of alumina for the smelter at Arak, Iran, in which Pakistan holds a 5% interest. A 1-ton-per-day alumina pilot plant was under construction at Khushab.

Philippines.—West Pacific Alumina Corp., an international consortium of eight metal producers, delayed a decision on the construction of a 770,000-ton-per-year alumina refinery on Mindanao. Bauxite for the project would be supplied on a long-term basis by Comalco from its Weipa deposits in Australia.

Surinam.—Bauxite was mined by Surinam Aluminum Co. (Suralco), an Alcoa subsidiary, and N.V. Billiton Maatschappij Suriname. Suralco also produced alumina and aluminum and converted bauxite to alumina for Billiton. Total exports of bauxite, most of which was shipped to the United States, decreased 41% to 2.29 million long tons in 1975. Exports of alumina increased 1% to 1.2 million short tons, of which 58% was shipped to Europe and 39% was shipped to the United States. Construction of a new bauxite calcining plant at Smalkalden by Billiton and Alcan was indefinitely postponed.

Taiwan.—A doubling of the capacity of Taiwan Aluminium Corp's alumina plant at Kaohsiung was expected to be completed by the end of 1976.

Yugoslavia.—Energoinvest began production in August at its new alumina plant at Bacevici near Mostar. Annual capacity of the plant was rated at 309,000 short tons. Another Energoinvest plant at Zvornik, also in Bosnia-Hercegovina, was due onstream in 1977 with a capacity of 660,000 tons per year. A third new alumina plant, with an annual capacity of 330,000 tons, was under construction for Jadral at Obrovac, Dalmatia. This plant was expected to be completed in 1976 and will use bauxite from Jadral's Jesenica, Krusevo, and Drnis mines.

The bauxite mines at Niksic, which supplied the Titograd alumina refinery, were under expansion to increase output from about 500,000 tons per year to 1 million tons by 1980 and to 1.5 million tons by 1985.

TECHNOLOGY

Increased costs of imported bauxite since 1974 and uncertainty about future supplies of bauxite from foreign countries have stimulated research and development on processes to use nonbauxitic aluminum resources in countries with insufficient bauxite resources. Pechiney and Alcan expected to complete construction of the pilot plant near Marseilles, France, in 1976. The plant will test the H-Plus process,[4] which uses both sulfuric acid and hydrochloric acid to recover high-purity alumina from shale, clay, and other low-grade aluminous materials. The plant was designed to produce 20 tons of alumina per day.

Construction was reported to have begun on a commercial-size plant in the Province of Kielce, Poland, to produce alumina from low-grade aluminiferous materials using the Grzymek process.[5] The plant was expected to produce 110,000 tons of alumina per year and several times that quantity of cement byproduct.

The joint venture of Earth Sciences, Inc., National Steel Corp., and Southwire Co. continued its research and planning for the production of alumina and fertilizer byproducts using alunite deposits in southwestern Utah. Under an agreement an-

[4] Cohen, J., and H. Mercier. Recovery of Alumina From Non-Bauxitic Aluminum Bearing Raw Materials. Light Metals, v. 2, 1976, pp. 3–18 (Proceedings of Sessions, 105th AIME Annual Meeting).

[5] Grzymek, J. Prof. Grzymek's Self-Disintegration Method for the Complex Manufacture of Aluminum Oxide and Portland Cement. Light Metals, v. 2, 1976, pp. 29–39, (Proceedings of Sessions, 105th AIME Annual Meeting).

nounced in April, funding for the group's proposed $360 million production complex would be the responsibility of National Steel and Southwire, each of which holds a 40% interest in the venture. Earth Sciences holds a 20% interest in the complex on a carried interest basis and a 50% interest in alunite properties the group has acquired outside Utah.

The Bureau of Mines continued its research on the recovery of alumina from domestic nonbauxitic aluminum resources.[6] The most promising technologies for extracting alumina from clay and other raw materials were being tested and developed in miniplants at the Bureau's Boulder City, Nev., laboratory. The miniplant program was initiated to evaluate the various processes on a comparative basis and to obtain cost and engineering data for the design and operation of large-scale demonstration plants. Ten companies were participating in the project with the Bureau on a cooperative, cost-sharing basis.

During 1975, a miniplant to treat kaolinitic clay using a nitric acid process was operated, and alternative methods for decomposition of the aluminum nitrate monohydrate produced in the process were investigated. A miniplant to process clay using a hydrochloric acid process was under construction, and test runs were made of the leaching and solvent extraction sections. Research on methods of processing anorthosite was conducted to obtain data for the design of a third miniplant.

[6] Barclay, J. A., and F. A. Peters. New Sources of Alumina. Min. Cong. J., v. 62, No. 6, June 1976, pp. 29–32.

Beryllium

By Benjamin Petkof [1]

Consumption of beryllium ore declined to almost half that of 1974. After five consecutive years of decline, imports of ore increased. Exports of beryllium products declined sharply. Domestic production of bertrandite continued to provide a substantial part of world beryllium minerals.

Table 1.—Salient beryllium mineral statistics

	1971	1972	1973	1974	1975
United States:					
Beryl, approximately 11% BeO:					
Shipped from mines ---------- short tons --	W	W	W	--	W
Imports ---------- do ----	4,026	3,345	1,586	1,368	1,479
Consumption [1] ---------- do ----	10,373	7,781	8,695	9,279	4,850
Price, approximate, per unit BeO, imported cobbed beryl at port of exportation -----	$33	$30	$30	$30	$30
Bertrandite ore: Utah, low-grade, shipped from mines ---------- short tons --	W	W	W	W	W
World production of beryl ---------- do ----	5,791	4,330	3,963	r 3,472	3,558

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes bertrandite ore which was calculated as equivalent to beryl containing 11% BeO.

Legislation and Government Programs.—In January 1975 legislation was introduced in the Congress to authorize disposal of excess beryl from the strategic stockpile. However, the Congress took no action during the year.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor published a proposed occupational safety and health standard for beryllium in the Federal Register, October 17, 1975. The proposed standard stressed measures against the potential carcinogenic effects of beryllium.

DOMESTIC PRODUCTION

Bertrandite ore accounted for most of the domestic commercial beryllium mineral production during the year. Brush Wellman Inc. (Brush) produced the bertrandite at its Spor Mountain mine in Millard County, Utah. A small quantity of beryl production was reported at Keystone, S. Dak.

Brush converted its ore to beryllium hydroxide at its facility at Delta, Utah, and then shipped the hydroxide to its Elmore, Ohio, facility for conversion to beryllium oxide, metal, and copper alloy.

Kawecki-Berylco Industries, Inc. (KBI) produced beryllium materials, principally from imported beryl. The company processed beryllium materials at its plants in Hazelton and Reading, Pa., into beryllium metal, copper alloy, aluminum alloy, and oxides.

Production in nearly all phases of the beryllium industry was down in 1975, largely owing to the general phasing out of the Department of Defense beryllium-consuming missile programs such as the Poseidon and the Minuteman.

[1] Physical scientist, Division of Nonferrous Metals.

CONSUMPTION AND USES

The domestic beryllium industry consumed beryllium ore equivalent to 4,850 tons of beryl containing a nominal 11% BeO, a decline of almost 50% from that of 1974. This decline reflected the Nation's general economic condition during the year, as well as decreased military and civilian requirements for beryllium metal, alloy, and oxide.

Beryllium metal consumption continued where a high stiffness-to-weight ratio was required in applications such as optics, X-ray transmission windows, aircraft brakes and structures, missile parts, and nuclear installations.

Products utilizing beryllium-copper alloys accounted for the greatest quantity of beryllium consumption. These alloys were used by the business machine, appliance, transportation, and communications industries. Beryllium-copper alloys were also widely used in electrical and electronic systems for connectors, sockets, switches, and temperature- and pressure-sensing devices to provide reliability and long service life.

Beryllium oxide ceramics found use in devices such as lasers, microwave tubes, and semiconductors. Power amplifiers for microwave and radio communications, electronic ignition systems, and power regulators were typical applications.

STOCKS

Consumer stocks of beryllium minerals totaled 3,546 tons at yearend 1975, a 20% decline from those of 1974. Dealers' stocks of beryl were not reported.

PRICES AND SPECIFICATIONS

With only very limited production of domestic beryl during the year, there were no known price quotations for domestically produced beryl. The price of any available domestic beryl was negotiated between buyer and seller. Metals Week quoted the price of imported beryl at $30 per short ton unit of contained BeO throughout the year.

At yearend the American Metal Market quoted the following prices for beryllium materials: Vacuum-cast metal ingot, $75 per pound; metal beads (97% purity), $61 per pound; metal powder, $56 to $63 per pound; metal rod, $125.55 per pound; beryllium-copper master alloy, $59 per pound of contained beryllium; beryllium-copper casting alloy, $2.02 to $2.79 per pound; beryllium copper in strip, rod, bar, and wire, $3.96 per pound; beryllium-aluminum alloy ingot, $72 per pound; and beryllium oxide powder, $26 per pound.

FOREIGN TRADE

Exports of wrought and unwrought beryllium alloys and of waste and scrap declined 74% in quantity but increased 4% in value over those of 1974. This was caused by high-value shipments during the year. The average value of exports increased almost fourfold, from $7.71 per pound in 1974 to $30.85 per pound in 1975, indicating greater overseas demand for higher valued finished beryllium forms. In terms of quantity, 94% of the total material exported went to the United Kingdom (31%), Canada (26%), Japan (15%), France (12%), Mexico (7%), and Switzerland (3%).

Beryl imports increased 8% in quantity and 13% in value over those of 1974. This was the first increase since 1969. The average value of imported material was $316 per ton, a 4% increase from that of 1974. Eighty percent of U.S. imports originated in Brazil (55%), the Republic of South Africa (17%), and Uganda (8%). In addition, 24,888 pounds of wrought, unwrought, and waste and scrap beryllium metal valued at $179,087 were imported.

Table 2.—U.S. exports of beryllium alloys, wrought or unwrought, and waste and scrap [1]

Country	1974 Quantity (pounds)	1974 Value (thousands)	1975 Quantity (pounds)	1975 Value (thousands)
Argentina	--	--	130	$1
Brazil	2,000	$8	--	--
Canada	41,008	69	9,787	75
Denmark	--	--	--	--
Finland	--	--	414	3
France	10,223	509	4,528	306
Germany, West	64,271	101	921	53
Ghana	500	2	--	--
India	10	2	16	1
Israel	5	1	5	1
Italy	21	6	771	30
Japan	17,466	215	5,529	203
Korea, Republic of	29	3	--	--
Mexico	3,896	7	2,500	2
Netherlands	11	6	20	9
Netherlands Antilles	--	--	--	--
Spain	22	1	--	--
Switzerland	1,531	26	1,073	28
Taiwan	--	--	100	1
United Kingdom	2,635	151	11,542	439
Total	143,628	1,107	37,336	1,152

[1] Consisting of beryllium lumps, single crystals, and powder; beryllium-base alloy powder; and beryllium rods, sheets, and wire.

Table 3.—U.S. imports for consumption of beryl, by customs district and country

Customs district and country	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Philadelphia district:				
Argentina	83	$22	110	$31
Australia	66	21	--	--
Brazil	607	215	779	276
Mozambique	27	7	--	--
Portugal	88	13	93	32
Rhodesia, Southern	--	--	42	15
Rwanda	44	12	22	3
South Africa, Republic of	280	87	207	50
Uganda	136	30	78	14
United Kingdom	19	4	--	--
Total	1,350	411	1,331	421
Baltimore district:				
Brazil	--	--	33	12
Mozambique	--	--	39	11
Uganda	--	--	38	12
Total	--	--	110	35
New Orleans district: South Africa, Republic of	--	--	[1]38	[1]12
New York City district: Rwanda	18	3	--	--
Grand total	1,368	414	[1]1,479	[1]468

[1] Adjusted by Bureau of Mines.

WORLD REVIEW

Total world production of beryllium minerals increased slightly during 1975. The bertrandite mining operation in the United States was believed to be the only mine operated solely for beryllium minerals. All other beryllium mineral production was in conjunction with production of other pegmatite minerals.

In the future, world production of hand-sorted beryl is likely to decline because of increasing labor costs and may be replaced by other beryllium minerals that can be mined and produced by continuous mining and processing methods.

Table 4.—Beryl: World production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
Angola	127	[r] [e] 100	[e] 35
Argentina	204	125	[e] 175
Australia	179	87	[e] 100
Brazil	1,334	[r] [e] 1,000	[e] 1,000
Malagasy Republic	3	14	17
Mozambique	1	9	[e] 10
Portugal	3	17	28
Rhodesia, Southern [e]	65	70	70
Rwanda	105	68	[e] 40
South Africa, Republic of	57	2	3
Uganda [e]	65	60	60
U.S.S.R.[e]	1,600	[r] 1,700	1,800
United States	W	W	W
Zambia [e]	220	220	220
Total	3,963	3,472	3,558

[e] Estimate. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] In addition to the countries listed, the Territory of South West Africa may also have produced beryl, but available information is inadequate to formulate reliable estimates of output levels.

TECHNOLOGY

A bibliography describing research conducted during the period 1964–75 on pollution of air and water by beryllium was published.[2] The report included information on sources, control, detection and analysis, and toxic effects on plants, animals, and humans.

An alloy containing 62% beryllium and 38% aluminum by weight was used for a primary structure in a high-speed aircraft. The alloy has the required stiffness at room temperature and at 600° F. Its use greatly increased the torsional and chordwise stiffness of the aircraft. As a result, this alloy is under consideration for structural and thermal protection applications in hypersonic research aircraft currently under development by the National Aeronautics and Space Administration and the U.S. Air Force.[3]

[2] Werner, K. G., and R. J. Brown. Beryllium Pollution. U.S. Dept. of Commerce (Springfield, Va.) NTIS/PS/-75/772 1975, 80 pp.
[3] Fullerton-Batten, R. C. Flight of YF-12 Marks Large Use of Lockalloy in Primary Structure. Am. Metal Market, v. 83, No. 46, Mar. 8, 1976, p. 26.

Bismuth

By John A. Rathjen [1]

United States bismuth consumption, production, and imports recorded significant declines in 1975, continuing trends which began in mid-1973. Consumption of refined bismuth dropped 878,000 pounds to 1.4 million pounds, the lowest annual usage since 1958. All of the major use categories decreased and cumulatively were about 38% less than in 1974. Exports of bismuth during 1975 were also reduced by approximately 61%, reflecting a lack of demand in world markets. Despite the general downtrend, the domestic producer price remained firm throughout the year averaging $7.72 per pound. World bismuth mine production declined 26%. The largest cutbacks, other than in the United States, were in Australia, Mexico, Japan, Canada and Yugoslavia which together produced 2.9 million pounds less than that in 1974.

Table 1.—Salient bismuth statistics
(Pounds)

	1971	1972	1973	1974	1975
United States:					
Consumption	1,648,718	2,315,534	2,906,219	2,283,978	1,406,021
Exports [1]	71,187	264,276	151,053	329,926	128,893
Imports, general	848,708	1,562,934	2,683,671	1,893,744	1,331,173
Price: New York, average ton lots	$5.26	$3.63	$4.92	$8.41	$7.72
Stocks Dec. 31:					
Consumer	1,107,215	717,466	540,756	596,757	451,250
World: Production [2]	8,330,000	8,808,000	r 8,205,000	r 10,639,000	7,888,000

r Revised.
[1] Includes bismuth, bismuth alloys, and waste and scrap.
[2] Excludes the United States.

Legislation and Government Programs.—Government stocks of bismuth remained at 2,100,004 pounds. Broken down, the total represents 585,892 pounds in the national stockpile, and 1,514,112 pounds in the supplemental stockpile. The stockpile objective is 95,900 pounds, indicating a surplus of 2,004,104 pounds which requires Congressional action for public disposal.

Bismuth remained on the list of commodities eligible for exploration assistance under the program administered by the Office of Minerals Exploration. Government participation remained at 75% of the exploration costs, but no contracts were in force during the year.

Federal income tax laws under the Tax Reform Act of 1969 provided a percentage depletion allowance of 22% for domestic production and 14% for U.S. companies producing from foreign sources.

[1] Mineral specialist, Division of Nonferrous Metals.

DOMESTIC PRODUCTION

Bismuth is produced essentially as a byproduct in the treatment of lead ores and bullion from foreign and domestic sources.

ASARCO Inc. continued as the only domestic producer of primary bismuth at its Omaha, Nebr. plant. Production in 1975 was reduced from the level of 1974 owing to depressed market conditions. A small quantity of bismuth was recovered from recycling of secondary material by the United Refining and Smelting Co. at Franklin Park, Ill. Refinery production statistics in the United States are withheld to avoid disclosing company confidential data.

An anticipated increase in domestic production from The Anaconda Company's Victoria mine in Elko County, Nev., did not materialize owing to a temporary shutdown of the Arbiter plant at Anaconda, Mont. Production is expected to resume in July 1976 with bismuth as a byproduct in the hydrometallurgical refining of complex copper ores.

CONSUMPTION AND USES

Consumption of bismuth in the United States during 1975 was 1.4 million pounds, a sharp drop from the 2.3 million pounds used in 1974. All major categories of use were affected, with the largest decrease occurring in fusible alloys which declined by 46% from that of 1974. Consumption as a metallurgical additive was also curtailed to about 62% of the 1974 level. Reductions in both these categories reflect a general sluggishness in the domestic economy which prevailed through 1975. Bismuth used in fusible alloys for the manufacture of fire control devices, forming dies, and holding fixtures, paralleled a decline in the construction and machine tool industries. Bismuth consumed as a metallurgical additive in the manufacture of certain cast iron, steel, and aluminum specialty metals also declined when foundries and mills reduced production schedules to meet lesser demand.

Bismuth used in pharmaceuticals, which include therapeutic, cosmetic, and industrial applications, also dropped sharply to 553,000 pounds, approximately 66% of the 1974 figure. The loss was primarily in industrial chemicals where bismuth is used as a catalyst in the manufacture of acrylonitrile. Use in cosmetics is also beginning to decrease as the "pearlescent look" gives way to changing fashion.

Table 2.—Bismuth metal consumed in the United States, by use
(Pounds)

Use	1974	1975
Fusible alloys	748,604	401,932
Metallurgical additives	668,932	416,200
Other alloys	21,417	26,007
Pharmaceuticals [1]	838,134	553,313
Experimental uses	305	713
Other uses	6,586	7,856
Total	2,283,978	1,406,021

[1] Includes industrial and laboratory chemicals and cosmetics.

STOCKS

Consumer stocks declined about 24% in the course of the year, ending at 451,000 pounds. Data on producer and dealer stocks are not available, however, it is generally believed that adequate supplies were being held pending an upward turn in demand.

PRICES

The domestic producer price for refined bismuth was lowered from $9 to $7.50 per pound during the first quarter of 1975, where it remained for the balance of the year. Dealer prices were quoted from $6.20 to $6.60 per pound early in the year, dropping to $5.55 to $5.60 at yearend. Reports that metal was available at a discount during November and December were attributed to cash liquidation of dealer stocks.

FOREIGN TRADE

Exports of bismuth in all forms dropped sharply in 1975 to a level of 129,000 pounds compared with 330,000 pounds during 1974. During 1975, bismuth was exported to 15 countries of which 6 accounted for 94% of total shipments. The principal countries receiving U.S. exports in order of declining volume were: Canada, 48,000 pounds, 37%; Belgium-Luxembourg, 38,000 pounds, 30%; the Netherlands, 13,000 pounds, 10%; West Germany, 10,000 pounds 8%; the United Kingdom, 7,000 pounds, 6%; and Spain, 4,000 pounds, 3%.

General imports of metallic bismuth during 1975 declined by 563,000 pounds to 1.3 million pounds. This reduction was attributed primarily to reduced demand in the domestic market. Six countries supplied about 87% of the U.S. import total during 1975. The United Kingdom was the largest shipper with 434,000 pounds, 33%; followed by Japan, 191,000 pounds, 14%; Mexico, 162,000 pounds, 12%; Peru, 141,000 pounds, 11%; the Republic of Korea, 126,000 pounds, 9%; and West Germany, 102,000 pounds, 8%.

Table 3.—U.S. exports of bismuth [1]

Year	Gross weight (pounds)	Value
1972	264,276	$492,585
1973	151,053	446,284
1974	329,926	1,520,105
1975 [2]	128,893	734,517

[1] Includes bismuth, bismuth alloys, and waste and scrap.
[2] Data shown subject to change, pending clarification by Bureau of the Census.

Table 4.—U.S. general imports of metallic bismuth, by country

Country	1974		1975	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Australia	1,873	$13	--	--
Belgium-Luxembourg	43,270	307	84,944	$596
Bolivia	90,501	727	--	--
Canada	89,892	947	51,143	409
France	--	--	22	(1)
Germany, West	222,043	1,799	102,290	802
Japan	337,115	3,005	190,962	1,256
Korea, Republic of	74,143	672	125,951	668
Mexico	292,544	1,971	161,834	955
Netherlands	22,114	207	4,349	23
Peru	459,204	3,757	140,630	1,177
United Kingdom	258,942	2,183	434,060	3,343
Yugoslavia	2,103	18	34,988	213
Total	1,893,744	15,606	1,331,173	9,442

[1] Less than ½ unit.

WORLD REVIEW

The worldwide tone of the bismuth industry in 1975 was generally depressed with levels of production, consumption, and international commerce lower than those in 1974. World production was curtailed as a result of depressed market conditions for bismuth as well as its primary host metals, copper and lead. Industry stock figures are not available on a global basis, however, it was felt in the trade that yearend inventories were larger than needed for normal working conditions.

Table 5.—Bismuth: World mine production, by country

(Thousand pounds)

Country [1]	1973	1974	1975 p
Australia (in concentrates)	1,001	2,578	e 930
Bolivia [2]	r 1,297	1,368	1,491
Canada (in ore)	71	245	81
China, People's Republic of (in ore) e	550	550	550
France (metal)	126	126	e 130
Germany, West (in ore) e	25	22	22
Japan (metal)	r 1,900	1,837	1,480
Korea, Republic of (metal)	r 218	289	249
Mexico [3]	1,290	1,583	981
Peru [3]	1,262	1,469	e 1,500
Romania (in ore) e	180	180	180
Spain (metal)	2	([4])	--
Sweden (in ore) e	33	33	33
Uganda (in ore) e	9	9	9
U.S.S.R. (metal) e	120	130	130
United States	W	W	W
Yugoslavia	121	220	122
Total	r 8,205	10,639	7,888

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] In addition to the countries listed Brazil, Bulgaria, East Germany and the Territory of South-West Africa are believed to produce bismuth, but available information is inadequate for formulation of reliable estimates of output levels.

[2] Production by COMIBOL, plus exports and local sales by medium and small mines.

[3] Bismuth content of refined metal, bullion and alloys produced indigenously, plus recoverable content of ores and concentrates exported for processing.

[4] Revised to zero.

Australia.—Bismuth mine production in Australia dropped sharply to 930,000 pounds of bismuth in 1975 from a record high in 1974 of 2.6 million pounds. The severe decline was attributed almost entirely to cessation of copper mining by Peko-Wallsend Ltd. at Tennant Creek, in the Northern Territory. Bismuth-bearing copper concentrate from this property was the prime source of Australian bismuth and output is not scheduled to be resumed until there is a substantial increase in the world price for copper. Peko-Wallsend Ltd. also produces a gold-bismuth bullion in the Northern Territory which is shipped via a circuitous route for gold recovery, and ultimate refining of bismuth in the United Kingdom. A lesser quantity of bismuth is also recovered from lead concentrates, produced in Australia, and shipped to other countries for smelting and refining.

Bolivia.—Bolivian production of bismuth in 1975 was 1.5 million pounds, virtually the same as output in 1974. Most of the bismuth was either mined directly from high-grade deposits or produced from complex ore bodies containing copper and tin values. Ore is treated at the Telamayu smelter of Corporación Minera de Bolivia, and a high-grade bullion is shipped abroad for refining. Feasibility studies are being conducted with regard to construction of a Bolivian refinery which would upgrade the entire bismuth production to marketable specification metal.

Canada.—Bismuth is obtained from processing ores containing lead, zinc, copper, molybdenum, or some combination thereof. During 1975, most of the Canadian metal production came from the lead smelter of Cominco Ltd. at Trail, British Columbia, where 81,000 pounds of bismuth was refined. A small quantity was also recovered by Brunswick Mining and Smelting Ltd. Corp., at Belledune, New Brunswick, and Gaspé Copper Mines Ltd. NPL in Quebec.

Japan.—Production of bismuth in Japan continued to drop, from almost 2 million pounds in 1972 to 1.5 million pounds in 1975. The largest part of this downturn was due to a loss of bismuth which traditionally came from Australia, although part of the drop can be attributed to a lower rate of lead smelting and refining during 1975.

Mexico.—Two companies accounted for the entire production of bismuth in Mexico during 1975. A combined total of 981 thousand pounds was produced by Industrial Minera Mexico, S.A., at its Chihuahua, Chihuahua plant, and Industrias Peñoles, S.A., at its Monterrey refinery in Nuevo Léon. Most of the bismuth was refined in Mexico and exported as a finished product, however, some of the metal was shipped in the form of bullion for refining in the United States and the United Kingdom.

Peru.—Production of bismuth during 1975 increased nominally to 1.5 million pounds. Treatment of copper-lead ores at the Oroya works of Minera-Peru continued as the sole source of bismuth in this country. Problems of reorganization under new ownership and curtailment of raw material from Bolivia were believed to be the cause of the drop in 1975 production.

Boron

By J. W. Pressler [1]

In a year of recession and with production cutbacks and inventory adjustments, U.S. production and consumption of boron minerals in 1975 declined slightly compared with that of 1974. However, the total value of sales and captive usage increased to almost $159 million, the largest amount in history. For shipments, it was the first back-to-back yearly decrease since 1961. Exports increased in 1975, inching up over that of 1974. With production being maintained at near peak levels, 25% to 30% capacity increases by major producers were being implemented and scheduled for operation by 1977. An increasing demand for insulation and textile fiberglass, coupled with a 20-year historical trend consumption growth rate of 2.3% in the U.S. borate industry, reinforced the decision of major producers to increase productive capacity commensurately.

The State of California continued to provide the entire U.S. output of boron minerals, mostly as sodium borates and boric acid but more recently some calcium borates. Imports of calcium borate (colemanite) from Turkey in 1975 increased appreciably over that of 1974.

Table 1.—Salient boron minerals and compounds statistics in the United States
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
Sold or used by producers:					
Quantity:					
Gross weight	1,047	1,121	1,225	1,185	1,172
Boron oxide	568	607	664	619	603
Value	$89,856	$95,882	$113,648	$128,306	$158,772
Imports for consumption: [1]					
Quantity	7	20	18	21	28
Value	$233	$626	$568	$852	$1,560

[1] Colemanite only.

DOMESTIC PRODUCTION

Domestic production and sales of boron minerals decreased very little in 1975 compared with those of 1974. Most of the output continued to come from Kern County, Calif., and to a smaller extent from San Bernardino and Inyo Counties, Calif.

At Boron in Kern County, the large open pit mine and refining plant belonging to U.S. Borax and Chemical Corp., a member of the RTZ Group of London, England, continued to be the world's chief source of boron, although Turkish tincal, colemanite, and refined products are rapidly becoming of great importance in world trade. U.S. Borax now processes over 10,000 tons of ore per day, producing principally crude sodium borate, refined sodium borate and boric acid, and their anhydrous varieties, at the mine site. Crude commercial-grade sodium borates, known as Rasorite 46 (pentahydrate borax) and Rasorite 65, the anhydrous equivalent, represent almost one-half of U.S. Borax's output in tonnage but only about one-third of the value.

[1] Physical scientist, Division of Nonmetallic Minerals.

During the year, the $54 million expansion project at Boron continued on schedule with a major portion of the new capacity to be onstream by 1977. This project will provide a 25% to 30% increase in the output of U.S. Borax's primary products, pentahydrate and decahydrate borax. The company's chemical plant at Wilmington, Calif., produced a variety of high-quality specialty borate products with a secondary function of serving as an overseas shipping point for bulk shipments. It was also planned that this chemical facility will be expanded by 25% to meet the increased demand for boric acid, in view of the strong growth projected for a large variety of end uses, including textile fiberglass, heat-resistant glass, cellulose insulation, and fire-resistant cotton batting. At Burlington, Iowa, U.S. Borax has a plant and warehousing facility for compounding, packaging, and distributing household soaps and other consumer products to the East and Midwest United States. These combined operations of U.S. Borax in the United States had an annual capacity of more than 600,000 tons of boric oxide (B_2O_3) equivalent (or about 190,000 tons of contained boron) in 1975, and when planned expansions are completed in 1977, the capacity will be 25% to 30% greater.

The company's production declined slightly during 1975, but with the midyear demand falloff, the company was able to replenish its stocks and concentrate on a substantial maintenance program at Boron, Calif., to restore and improve the production capability of the plants following the difficult period of the long strike in 1974. At the same time, engineering work was undertaken in preparation for a planned increase in production capacity to meet future demands.

U.S. Borax also maintains a warehouse and distribution facility at Botlek, Netherlands, from which borax and boron chemicals are shipped to other parts of Europe.

At Searles Lake, Kerr-McGee Corp. operated the Trona and Westend plants, with combined capacities of approximately 130,000 tons of B_2O_3 equivalent per year. Borates were produced along with potash, soda ash, lithium salts, and sodium sulfate from the mineral-rich brines. The Westend plant has a capacity of 30,000 tons per year of B_2O_3 equivalent as decahydrates. The flowsheet is based upon the carbonation process. At the nearby Trona plant, Kerr-McGee utilizes a differential evaporative process with a productive capacity of 100,000 equivalent tons of B_2O_3 per year, including 150 tons per day of anhydrous borax and 80 tons per day of boric acid. A major new soda ash plant is being constructed adjacent to these existing facilities, but a borate cycle apparently is being deferred until the recovery economics are feasible.

In 1975, Tenneco, Inc., increased production of colemanite and ulexite from its Ryan mine near Death Valley, Inyo County, Calif. The colemanite (calcium borate) is processed at a plant at Lathrop Wells, Nev., utilizing calcination and screening for the principally fiberglass market. The ulexite is trucked to a plant at Dunn, Calif., where it is prepared for the market by grinding to minus 200 mesh. Its principal use is in the manufacture of glass wool insulation and fire-retardant chemicals. At yearend, Tenneco had increased its reserves as a result of exploration and development and had approved a plan to double its production with a capital investment of $20 million within 3 years. However, the environmental impact of increased mining activities in the Death Valley National Monument has resulted in considerable public opposition to any commercial mining, and a bill was introduced in Congress to prohibit any further mineral exploration and mining in the monument. This, of course, has deferred any of Tenneco's plans for future development until it can be resolved.

CONSUMPTION AND USES

Measured in terms of boron content, U.S. consumption was probably about 98,000 tons in 1975, compared with possibly 110,000 tons in 1974 and 114,000 tons in 1973. Beginning with 1975, U.S. consumption of boron materials will be more accurately estimated than in the past. While official U.S. trade statistics will continue to report only exports of refined boron products, with the cooperation of the U.S. producers, crude borate export data will also be made available. These crude product exports have never been reported by the Bureau of the Census.

With these figures, a reasonably accurate consumption figure will be available each year. Only U.S. Borax exported any borates in 1975. Almost 50% of the U.S. output of boron minerals and compounds was exported, while the balance was consumed domestically.

The average annual U.S. consumption of boron compounds during the last 5 years has been roughly 100,000 tons of boron content. About one-half, or 50,000 tons, goes into the manufacture of all kinds of glasses and ceramic uses. Boron materials are used up to 10 weight-percent in most specialty glasses and with an intrinsic value of up to 75% of the total composition. Almost 20,000 tons per year goes into insulating glass wool, which has been gaining sharply as a result of increasing energy costs. High quality and specialty glasses consumed almost 12,000 tons per year, and textile fiberglass consumed over 10,000 tons per year. Enamels, frits, and glazes consumed about 8,000 tons per year for protective and decorative coating on sinks, stoves, refrigerators, and other household and industrial appliances.

The average annual U.S. consumption of boron compounds in soaps and cleaners has been over 12,000 tons of boron content, including about 7,000 tons in sodium perborate detergents used in higher temperature washing. In addition, the chemical derivatives require at least another 10,000 tons per year of boron content. Perborates are used as a bleaching agent or as a source of active oxygen in laundry products. Borohydrides have a growing use as chemical reductants in such important industrial processes as regeneration of sodium hydrosulfite in reductive pulp bleaching. Borax and boric acid uses in the cleansing field include toothpaste, mouthwash, eyewash, etc. Approximately 8,500 tons of boron yearly is used in the manufacture of biological and growth-control chemicals for use in algicides and water treatment, fertilizers, herbicides, and insecticides.

Two minor but important uses—corrosion inhibitors in antifreeze and as fire-retardants—together consume as much as 5,000 tons of boron content per year. Fire-retardant chemicals such as zinc borate are enjoying a very rapid growth in this market.

The list of miscellaneous uses is very diverse: Borates as fluxing material and as shielding slag in the nonferrous metallurgical industry; borate compounds as components in plating baths in the electroplating industry; ferroboron in small amounts in specialty steels; boron in nonferrous alloys such as surfacing metal that is subject to heavy wear; boron nitride compounds as abrasives; boric acid as a catalyst in the air oxidation of hydrocarbons to key nylon intermediates, in the oxidation of paraffins to higher alcohols, as intermediates for surfactants, and as a conditioning agent in the manufacture of ammonium nitrate; various boron products used in pharmaceuticals, paper, textile, leather, nuclear shielding, photography, paints and varnishes, adhesives, and pyrotechnics; and in a few commercial automotive fuels as boron esters to inhibit surface ignition and spark plug fouling.

U.S. demand for boron minerals and compounds is expected to increase substantially in view of the strong growth projected for a large variety of end uses, including textile fiberglass, heat-resistant glass, cellulose insulation, and fire-resistant cotton batting.

PRICES [2]

No U.S. price increases for boron minerals occurred in 1975. In 1974, a series of four increases resulted in raises of from 23% to over 80% during the year, depending on the product. The average value of 1975 borate shipments was \$263 per ton of B_2O_3 compared with \$207 in 1974. Costs of producing anhydrous products were particularly hard hit by increases in fuel oil and natural gas prices. Although 1975 borate prices remained unchanged, U.S. producers near the end of the year announced price increases of at least 12% to take effect at the beginning of 1976. The sharply rising cost of natural gas for industrial purposes in California was a major factor in the announced price increases. Quoted rounded dollar prices for various borate products are shown in table 2.

[2] Watt, G. R. Boron. Min. Eng., v. 28, No. 3, March 1976, p. 31–32.

Table 2.—Borate prices per short ton, 1975[1]

Product	December 31, 1975
Borax, technical, anhydrous, 99%, bulk, works	$188–$203
Borax, technical, pentahydrate, 99½%, bulk, works	98– 105
Borax, technical, decahydrate, 99½%, bulk, works	81– 82
Boric acid, technical, 99.9%, bulk, works	199– 202
Colemanite, Tenneco, calcined and screened, minus 70 mesh, 47% B_2O_3, f.o.b., railcars, Dunn, Calif	[2]145– 150
Colemanite, Turkish, 42% B_2O_3, crude, lump, f.o.b. railcars, U.S. east coast port	[3]100– 110

[1] Chemical Marketing Reporter, Dec. 29, 1975. Other conditions of final preparation, transportation, quantities, and qualities are subject to negotiation and somewhat different price quotations.
[2] Tenneco, private communication.
[3] Phillips Bros., private communication.

FOREIGN TRADE

U.S. exports of boric acid were 33,697 tons valued at $11.5 million in 1975, compared with 35,740 tons in 1974. Exports of refined sodium borate also showed a small decrease—to 212,300 tons valued at $42.5 million in 1975, from 218,107 (revised) tons in 1974. In addition, a large amount of crude sodium borate was exported which was not reported in U.S. trade statistics. Exports of crude sodium borate also suffered from a slackening demand as the result of the recent recession and dropped off about 10% in 1975.

A detailed breakdown of reported exports in 1975 is shown in table 3. Within this table, data for all countries outside Western Europe are fairly accurate. For Western Europe, the Netherlands is a major transshipment point rather than the final destination. A more meaningful tabulation of recipient nations, including an estimate for crude borates, would show that West Germany, France, the United Kingdom, Belgium, and Spain were ahead of the Netherlands, in that order.

In 1975, the United States imported 27,641 tons of commercial-grade colemanite (calcium borate) valued at $1,560,000, all from Turkey. This compared with 21,214 tons, valued at $852,000, in 1974.

Table 3.—U.S. exports of boric acid and sodium borates, in 1975

Destination	Boric acid (H_3BO_3 content)		Sodium borates (refined)	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	2,707	$911	6,621	$1,160
Austria	221	119	184	61
Belgium-Luxembourg	38	24	130	45
Brazil	2,552	1,067	7,107	1,470
Canada	2,467	673	32,576	4,648
Colombia	571	214	1,039	193
Costa Rica	17	7	192	37
Dominican Republic	32	17	80	13
El Salvador	--	--	334	133
Finland	23	9	426	79
France	--	--	19	6
Germany, West	1,651	668	340	82
Greece	64	20	137	16
Guatemala	9	4	37	12
Hong Kong	196	68	4,740	1,015
Indonesia	112	49	1,774	253
Iran	18	6	656	147
Israel	280	89	599	92
Italy	79	18	180	22
Japan	9,946	3,144	32,935	6,720
Korea, Republic of	942	311	5,765	697
Lebanon	45	18	281	55
Malaysia	84	30	235	39
Mexico	2,466	636	19,012	3,060
Norway	146	34	98	12
Netherlands	3,979	1,555	58,091	14,323

See footnotes at end of table.

Table 3.—U.S. exports of boric acid and sodium borates, in 1975—Continued

Destination	Boric acid (H_3BO_3 content) Quantity (short tons)	Boric acid (H_3BO_3 content) Value (thousands)	Sodium borates (refined) Quantity (short tons)	Sodium borates (refined) Value (thousands)
New Guinea	104	$44	122	$31
New Zealand	469	159	3,228	1,011
Nicaragua	--	--	57	22
Peru	129	59	269	44
Philippines	262	86	607	122
Pakistan	241	115	833	125
Singapore	424	113	473	70
South Africa, Republic of	1,072	378	3,543	877
Surinam	15	5	100	25
Sweden	138	51	146	17
Switzerland	16	5	78	9
Taiwan	792	264	4,317	648
Thailand	213	81	947	176
United Kingdom	195	39	21,980	4,462
Uruguay	89	27	39	10
Venezuela	532	223	1,437	328
Vietnam, South	--	--	134	16
Yugoslavia	93	57	--	--
Other	268	135	368	103
Total	33,697	11,532	212,266	42,486

WORLD REVIEW

Argentina.—Although borate deposits are known in Bolivia, Chile, and Peru, Argentina remained the only known producer during 1974 and 1975, with borate mineral output each year of 86,000 short tons. Boroquimica, a RTZ Borax Ltd. subsidiary, produced the major portion of the output from its Tincalayu mine in the Salar del Hombre Muerto basin in the Salta region of northwest Argentina. A small production also came from the Compañía Productora de Boratos. Most of the output was consumed domestically, with some exports to other countries in the Latin America Free Trade Area, mainly Brazil.

China, People's Republic of.—The People's Republic of China produces a sufficient but relatively unknown amount of borate minerals, and little is known about the industry. China is understood to have recently built a number of fiberglass plants, which will undoubtedly consume borates in the manufacturing process. This development is in addition to the previously reported construction of a large borax plant at Iksaydam, adjacent to the best known borate occurrence. A moderate output of borate minerals also comes from the playa lake deposits in Sinkiang Province and Tibet, the original source of the first commercial trading of borax minerals with Europe in the 13th century. Small shipments totaling approximately 600 tons of borate minerals were exported to Japan in 1975, while 115 tons of refined products, mostly borates and perborates, were imported from Japan.

Turkey.—Production of borate minerals in Turkey in 1975 was 1,070,000 tons of 27% to 46% B_2O_3 content, the equivalent of 391,000 tons of contained B_2O_3, as provisionally reported by the Turkish Statistical Institute and by the Turkish Mineral Research and Exploration Institute (MTA).

Although 10% less than the record high level of 1974, this plateau represents a doubling of production from the 1973 level of 211,000 tons of contained B_2O_3. Considering ore reserves, present and planned capability, government policy, and the world market for Turkish borates, another major increase in production will take place in the near future.

Turkey now rivals and is a strong competitor of the United States in the production of boron minerals for the world market, and has some transportation cost advantages over the United States in the European market. Refined borax and boric acid are manufactured in the Bandirma and Edincik processing plants of Etibank and exported to all European countries, including the Soviet bloc, and also the Far East, including Japan. In the near future, borax ore mined near Kirka will be processed in an 800,000-ton-per-year complex in the vicinity of the mine. This mine, owned by Etibank, has 96% of the total boron reserves in Turkey.

Etibank, the Turkish Government mining corporation and leading producer with 98% of the boron reserves and more than two-thirds of the production, continued a very aggressive expansion program to produce a variety of refined boron compounds for its traditional European markets. Although some marketing difficulty was experienced during 1975, it was forecast that these markets will recover in 1976. The borate production facilities of Turkey are centered in three principal areas—Kirka, Emet, and Bandirma.

Kirka is located about 45 miles south of Eskisehir in west-central Turkey. Diamond drilling of this tincal deposit was conducted in 1968–69, and possible reserves were estimated at 550 million tons. Mine development by Etibank started in 1970 on ore with an average grade of 26% to 27% B_2O_3 with a trace of arsenic. Shipments of crude ore from Kirka have been the feedstock for the borax and boric acid refinery at the port city of Bandirma, over 200 miles away by rail. A washing and screening plant was established at the mine site in 1974 with an annual capacity of 440,000 tons per year of 35% B_2O_3 upgraded tincal concentrate. Etibank plans to start construction in early 1976 of refining facilities at the Kirka mine site, utilizing the 35% tincal concentrate for the production of 200,000 tons per year of crude borax pentahydrate, 55,000 tons per year of crude anhydrous borax, 19,000 tons per year of refined borax decahydrate, and 10,000 tons per year of refined anhydrous borax. The excess 35% tincal concentrate will continue to be feedstock for the present and expanded refining facilities at Bandirma.

Emet is about 60 miles by air due south of Bursa in west Turkey. Here Etibank has been operating two colemanite mines since 1974—the Hisarcik open pit mine near Emet, and the Espey underground mine, together which have possible reserves of over 11 million tons, the second largest boron reserve in Turkey next to Kirka. Emet is about 150 miles by rail from Bandirma. Etibank has been operating a washing and screening plant at Hisarcik with a feed capacity of 660,000 tons per year of crude colemanite (27% B_2O_3) ore. Ratio of concentration is about 2 to 1, and the plant produces about 330,000 tons per year of upgraded colemanite sized into three products with an average grade of 42% B_2O_3. This product is then shipped by rail to Bandirma for use as feedstock in the chemical refineries, or exported directly to European, U.S., and Japanese markets.

At present, about one-half of the tincal concentrate from Kirka and the colemanite concentrate from Emet, received at Bandirma and Edincik, is exported; the balance becomes feedstock for the present and expanding refining facilities. Built in 1968, the Bandirma plant now has a capacity of 60,000 tons per year of refined borax pentahydrate and 28,000 tons per year of refined boric acid. The borax refining plant uses tincal concentrate from Kirka, and the boric acid refining plant uses both Kirka tincal concentrate and Emet colemanite concentrate. A recent refinery addition is a sodium perborate plant with a capacity of 22,000 tons per year. Etibank has finalized plans and initiated construction of four more plants to be finished by 1978 as follows: (1) A second boric acid plant with a capacity of 110,000 tons per year, (2) a second sodium perborate plant with a capacity of 28,000 tons per year, (3) a hydrogen peroxide plant with a capacity of 22,000 tons per year, and (4) an α-hemihydrate byproduct gypsum plant to utilize the waste calcium sulfate from the colemanite processing plants. Thus, it can be seen that Etibank has aggressive plans for expansion of production, including refinery facilities.

The private sector of the borate mining industry has produced 35% to 40% of the total production of Turkey in recent years. However, its reserves at Beyendiler, Salmanli, Camkoy, Farajkoy, Kadikoy, and Calcagi are quite small in comparison with those of Etibank—only 1.54%, or 7.8 million tons, of the total possible reserves of Turkey. Coupled with the large expansion program of Etibank, and government policy relative to private industry in Turkey, their share of borate mineral production will be progressively reduced and will be relegated to a small secondary position. Hence, the talk in recent years of nationalization of the boron industry will be passé.

U.S.S.R.—The borate deposits in the Inder Lake region north of the Caspian

Sea continued to be the major source of the U.S.S.R.'s output in 1975, reportedly at a level approximating 250,000 tons of borate minerals per year. Output is mainly from several deposits in fracture zones around a large salt dome. Although exploration has led to borate discoveries in various parts of the U.S.S.R., the bulk of the production continues to come from the Inder Lake district in Kazakh S.S.R., with some from the Sikhote Alin mountain range in eastern Siberia, northeast of Vladivostok. Apparently, magnesium borate shows a preponderance in production over the sodium and calcium compounds. With the exception of small sporadic imports from Turkey, the U.S.S.R. is self-sufficient in its borate requirements, with some exports to other countries in the Soviet bloc. Estimating the U.S.S.R. production at a level of 250,000 tons per year of borate minerals, domestic consumption could be as much as 220,000 tons per year, with most of the remainder exported to eastern European countries, except for a small amount to Japan (which probably represents production from the Sikhote Alin mountains). In 1975, Japan reported imports of Russian crude borates of 1,720 tons, 2,130 tons of boric acid, and 170 tons of other borates.

Other.—India has recently announced tentative plans for a plant capable of producing up to 200 tons of borax annually from the country's limited reserves,[3] in a sulfur-gypsum deposit in the Ladakh district of northwest India. The only other known production in the world is a small amount of byproduct magnesium borate recovered from potash deposits in West Germany.

TECHNOLOGY

Although it was reported that the Turkish steel industry is using colemanite instead of fluorite for flux in the BOF and open-hearth refining of steel, the U.S. and Canadian steel industry has not gone beyond test runs because of the adverse effect on quality, as any boron entering the steel has a deleterious hardening effect, especially in steel plate. Also, economic incentives are not attractive at this time.

Eagle-Picher Industries of Cincinnati, Ohio, under a contract with the Energy Research and Development Administration (ERDA), will construct a facility for the production of high-purity boron-10 metal powder at Quapaw, Okla.[4] The metal will be used in a wide range of applications where neutron absorption is required. The capacity of the plant will be increased from a nominal 50 kilograms of contained boron-10 per year to over 1,500 kilograms per year.

[3] Industrial Minerals. Company News and Mineral Notes. November 1975, p. 53.

[4] Tulsa Daily World. Quapaw Plant in Excess of $90 Million. Sept. 10, 1976.

Bromine

By Charles L. Klingman [1]

The market for bromine was depressed in certain applications in 1975 which resulted in a 6% drop in production. The losses could be attributed to decreased sales of flameproofers for carpets, fabrics, and plastics and to less need for ethylene dibromide, a gasoline additive. There were increases, however, in production of methyl bromide, an agricultural chemical, and in elemental bromine. The higher demand for elemental bromine was a result of greater usage in sanitation and chemicals, plus increased exports.

Despite a lower rate of production, the future market for bromine apparently looked good. Four of the bromine producers announced building programs which should provide sizable increases in capacity within 2 years. A new container for handling bulk shipments of elemental bromine, which was approved by the U.S. Coast Guard in 1975, should facilitate exportation of elemental bromine to all parts of the world.

The average unit price of elemental bromine sold increased 4%, and the unit prices of bromine compounds increased an average of 15% in 1975, compared with the prices of 1974. With higher prices, the 1975 value of elemental bromine plus compounds was greater than that of 1974 despite decreased production.

The future of the bromine industry depends, to a large extent, on the amount of tetraethyl lead allowed by the Federal Government in automobile gasolines. Ethylene dibromide is required as a scavenging agent for the lead whenever it is used. At yearend, the future of lead in gasoline was confused. A lawsuit by the Ethyl Corp. and others against the Environmental Protection Agency (EPA) on this subject was to be appealed to the U.S. Supreme Court. The outcome of this court decision is of critical importance to the bromine industry.

Legislation and Government Programs.— The mainstay of the bromine industry, ethylene dibromide, a gasoline additive, was affected in 1974 and 1975 by regulations of the EPA which virtually precluded the use of lead additives in gasoline for new automobiles. A lawsuit was filed by Ethyl Corp. and others against the EPA claiming that there was no proof that lead in gasoline was a public hazard and that the EPA had exceeded its authority. In 1974, a lower court ruled in favor of Ethyl Corp., but in late 1975, an appeals court reversed the decision in favor of EPA. An appeal to the U.S. Supreme Court was pending at yearend, and the entire matter of lead in gasoline (and its attendant ethylene dibromide) was left unresolved. Regardless of future developments, however, the bromine industry has already felt the effects of the loss of a portion of the gasoline additive business.

In a recent change of position, the EPA withdrew its previous objection to the generation of sulfuric acid by catalytic converters which preclude the use of additives such as ethylene dibromide.

The bromine industry of Arkansas was under investigation in 1975 by a State-appointed Brine Study Commission. Possible pollution problems, royalty rates paid to landowners, and severance taxes were to be analyzed by the committee. At yearend, the study was continuing.[2]

Ethylene dibromide was singled out as a possible carcinogen by the National Cancer Institute, but at yearend no regulations had been issued by a government agency to limit the production or use of this compound.[3]

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[1] Physical scientist, Division of Nonmetallic Minerals.

[2] Shiras, G. Bromine Industry Problems to be Studied by Panel. Arkansas Gazette. Jan. 21, 1976, pp. 1–2.

[3] Chemical Age. Ethylene Dibromide is Carcinogen Says NCI. V. III, No. 2923, July 25, 1975, p. 6.

DOMESTIC PRODUCTION

Total domestic production of elemental bromine decreased 6% in 1975 to 407,163,000 pounds from the 1974 alltime peak. This represented 68% of the nominal production capacity of the industry as reported in the literature.[4] A breakdown of the components of production indicates declines in the manufacture of ethylene dibromide and "other" bromine compounds (including flame retardants) and gains in methyl bromide and elemental bromine. Geographic analysis showed little change in production patterns between 1974 and 1975. Arkansas continued to produce over three-fourths of the national bromine output.

The value of all bromine production, compounds plus elemental, was $5.5 million greater in 1975, an increase of about 3% over the 1974 value. The unit value of elemental bromine increased about 4%, while the average price of the compounds produced increased nearly 15%.

The difference between the quantity of bromine used in the manufacture of compounds (table 1) and the calculated bromine content of the compounds produced (table 2) indicated a loss of about 3.8% in 1975. This was a much greater loss than that evidenced in past years.

Table 1.—Elemental bromine sold as such or used in the preparation of bromine compounds by primary producers in the United States
(Thousand pounds and thousand dollars)

	1974		1975	
	Quantity	Value	Quantity	Value
Sold	45,760	12,177	57,410	15,871
Used	386,334	105,538	349,753	97,255
Total	432,094	117,715	407,163	113,126

Table 2.—Bromine compounds sold by primary producers in the United States
(Thousand pounds and thousand dollars)

	1974			1975		
	Quantity			Quantity		
	Gross weight	Bromine content	Value	Gross weight	Bromine content	Value
Ethylene dibromide	295,070	252,664	66,560	267,523	227,582	69,806
Methyl bromide	20,048	17,472	9,396	24,161	20,336	10,618
Other compounds [1]	157,166	112,510	106,186	124,151	88,611	103,487
Total	472,284	382,646	182,142	415,835	336,529	[2] 183,912

[1] Includes hydrobromic acid, tetrabromobisphenol, ethyl, ammonium, sodium, potassium, and other bromides.
[2] Data do not add to total shown because of independent rounding.

From 1% to 2% of the U.S. bromine production is consumed by certain organic chemical industries and is therein reduced to sodium bromide solutions. These waste solutions are sold in bulk to bromine-producing companies which recycle them as plant feedstock.

Elemental bromine sold to nonmanufacturers of bromine compounds amounted to 14% of the production, up from 11% in 1974.

Optimism for the future of the bromine industry seemed to be high as indicated by announced increases in production capacity by four of the bromine producers. Ethyl Corp. planned to build two new plants at a cost of about $15 million. The first, scheduled to be completed in the fall of 1976, was intended for manufacture of intermediate bromine compounds for agricultural chemicals. The second was scheduled to be onstream in the spring of 1977 and

[4] Chemical Marketing Reporter. Bromine Chemical Profile. V. 209, No. 14, Apr. 5, 1976, p. 9.

was designed for production of the intermediate alkyl dimethylamine, used in the manufacture of germicides, petroleum chemicals, and other specialized products.[5]

Michigan Chemical Corp. announced construction of an additional $9 million facility to manufacture flame retardant chemicals. The plant was scheduled to be in operation by the spring of 1977.[6]

In early 1976, The Dow Chemical Co. was scheduled to bring onstream two new production units at Magnolia, Ark. One of the plants will approximately double Dow's capacity for making elemental bromine, and the other was planned for the production of a brominated soil fumigant for agricultural use.[7]

By the end of 1975, Great Lakes Chemical Corp. was close to completion of its new Marysville, Ark., plant. This plant's capacity was reported to be 45 million pounds of bromine per year. Great Lakes also formed a jointly owned company with a European company, Produits Chemiques Ugine Kuhlmann (PCUK), for marketing flame retardant chemicals in North America.[8]

In 1975, there were 10 bromine-producing plants operated in 3 States by 7 companies. Two of these plants produced elemental bromine only, and one each produced ethylene dibromide, methyl bromide, and inorganic bromides. The remaining five plants produced a variety of compounds and elemental bromine. Two plants in Texas made compounds from purchased bromine and hence were not primary producers.

Three bromine companies produced 82% of the U.S. output. Table 3 lists the current bromine producers of the United States.

U.S. resources are vast, although their full potential is unknown. If the rich brine sources should fail, there are unlimited reserves of dilute bromine in the oceans.

Table 3.—Bromine-producing plants in the United States

State and company	County	Plant	Production source
Arkansas:			
Arkansas Chemicals, Inc	Union	El Dorado	Well brines.
Ethyl Corp	Columbia	Magnolia	Do.
The Dow Chemical Co	do	do	Do.
Great Lakes Chemical Corp	Union	El Dorado	Do.
Michigan Chemical Corp	do	do	Do.
California:			
Kerr-McGee Chemical Corp	San Bernardino	Trona	Searles Lake brines.
Michigan:			
The Dow Chemical Co	Mason	Ludington	Well brines.
do	Midland	Midland	Do.
Michigan Chemical Corp	Gratiot	St. Louis	Do.
Morton Chemical Co	Manistee	Manistee	Do.

CONSUMPTION AND USES

Ethylene dibromide output dropped 9% in 1975 compared with that of 1974; this was in addition to a drop of 12% between 1974 and 1973. The decrease in consumption of ethylene dibromide, a gasoline additive, was due to mandatory changes in 1974–75 automobiles which precluded their use of "leaded" gasoline. When tetraethyl lead was not used, there was no need for ethylene dibromide in gasoline. The decrease in consumption of ethylene dibromide may continue in future years.

There was also a distinct drop in consumption of "other" bromine compounds which included hydrobromic acid, the bromides of sodium, potassium, and ammonia, and a host of organic bromides. Flame retardant bromides dropped in 1975, probably because of reduced output of synthetic fibers, carpets, rugs, and plastics in which

[5] Chemical Marketing Reporter. Ethyl Corporation Expanding Bromine Chemical Units. V. 209, No. 13, Mar. 29, 1975, pp. 3, 24.

[6] Chemical Marketing Reporter. Flame Retardants Unit Going Up in Arkansas for Michigan Chemical. V. 209, No. 16, Apr. 19, 1976, pp. 5, 22.

[7] Chemical Engineering. CPI News Briefs. V. 82, No. 1, Jan. 6, 1975, p. 136.

[8] News Release by Great Lakes Chemical Corp. Feb. 2, 1976, and Feb. 20, 1976.

flameproofers were used. One source[9] predicted, however, that flameproofer demand will increase about 40% by 1980. Strict governmental standards for flammability have been a factor in creating this bromine market.

Methyl bromide, used primarily as a soil sterilant, showed a 4.1-million-pound gain in 1975. Since 1962, production of methyl bromide has displayed an average annual growth of 7%. Much of this new production was apparently exported from the United States.

Sales of elemental bromine also showed an increase of 11.7 million pounds in 1975, 2.7 million of which could be attributed to increased exports. Elemental bromine was used as a disinfectant, algaecide, a chemical oxidizer, and, of course, as an ingredient in the manufacture of bromine compounds.

PRICES

The average price of bulk elemental bromine f.o.b. plant as reported by producers in 1975 was 27.65 cents per pound, 4% higher than the 1974 average price. This increase was less than the industry-wide rate of inflation, however, so the effective bromine price on a constant-dollar basis was lower in 1975 than in 1974.

Prices quoted in the Chemical Marketing Reporter as of December 29, 1975, for bromine and certain of its compounds are shown in the following tabulation:

	Value per pound (cents)
Bromine; purified:	
Carlots, truckloads, delivered	75
Drums, carlots, truckloads, delivered east of Rocky Mountains	55–62
Zone I: [1] Bulk tank car, tank trucks (45,000-pound minimum), delivered	25–30
Ammonium bromide, national formulary (N.F.), granular, drums, carlots, truckload, freight equalized	74
Bromochloromethane, drums, carlots, freight equalized	73
Tanks, same basis	71
Ethyl bromide, technical, 98%, drums, carlots, freight allowed, East	61½
Ethylene dibromide, drums, carlots, freight equalized	37
Methyl bromide, distilled, tanks, 140,000-pound minimum, freight allowed	41
Potassium bromate, granular, powdered, 200-pound drums, carlots, f.o.b	106
Potassium bromide, N.F., granular, drums, carlots, f.o.b	67
Sodium bromide, 99% granular, 400-pound drums, freight, F.o.b	65

[1] Delivered prices for drums and bulk shipped west of the Rockies, 1 cent per pound higher. Bulk truck prices 1 cent per pound higher for 30,000-pound minimum and 2 cents per pound higher for 15,000-pound minimum. Price f.o.b. Midland and Ludington, Mich., freight equalized 1 cent per pound lower.

FOREIGN TRADE

The entire amount of bromine exported from the United States in 1975 (both as the element and that contained in compounds) dropped about 6% below the 1974 total, but the value of the exports increased around 10% owing to a rise in prices. The total value of exported compounds was about 25 times that of the elemental exports. Exported compounds dropped about 12% in quantity, in contrast with a 296% gain in exported elemental bromine. The total amount of bromine exported remained at about 16% of the total domestic bromine production.

In 1975, approval was obtained from the U.S. Coast Guard for the use of a new container for elemental bromine which should facilitate overseas shipments of liquid bromine.

Imports of bromine remained too small to tabulate, amounting to less than one-half percent of domestic production. About 70% of the imports came from Canada.

[9] Chemical & Engineering News. V. 54, No. 12, Mar. 22, 1976, p. 13.

Table 4.—U.S. exports of bromine and bromine compounds
(Thousand pounds and thousand dollars)

Year	Elemental bromine		Bromine compounds		
	Quantity	Value	Gross weight	Contained bromine	Value
1973	535	NA	48,300	40,683	NA
1974	918	260	82,082	68,427	24,195
1975	3,635	1,037	72,395	61,598	25,791

NA Not available.

WORLD REVIEW

Israel.—Dead Sea Bromine, Ltd., reportedly will increase its bromine production capacity to 55,000 tons (110 million pounds) per year by 1979 by building a new 27,500-ton-per-year chlorine plant in Israel.[10]

The Dead Sea Co. also announced that it would build a new $12 million plant at Terneuzen, the Netherlands, to produce 7,500 tons of bromine compounds per year from Israeli bromine. A tariff-reducing agreement with the European Economic Community facilitated the decision.[11]

Table 5.—Bromine: World production, by country [1]
(Thousand pounds)

Country [2]	1973	1974	1975 [p]
France	36,685	35,009	[e] 33,000
Germany, West	[e r] 9,900	11,581	9,414
India [e]	550	600	600
Israel	28,748	39,683	[e] 39,700
Italy [3]	8,686	[e] 8,400	[e] 7,700
Japan [e]	24,300	25,100	24,700
Spain	1,049	926	[e] 1,000
United Kingdom	67,461	59,966	[e] 62,000
United States	418,250	432,094	407,163

[e] Estimate. [p] Preliminary. [r] Revised.
[1] Owing to incomplete reporting, this table has not been totaled.
[2] In addition to the countries listed, several other nations produce bromine (including most notably, the U.S.S.R.), but output data are not reported and no basis is available for estimation of output levels.
[3] Elemental bromine from thermal and marine waters only: Additional bromine may be produced in the form of compounds and/or as elemental bromine from other sources.

TECHNOLOGY

Bromine chloride was being investigated as an improved chemical for water treatment. It was found to be less toxic than chlorine alone and possibly more effective as a disinfectant. If accepted by the water treatment industry, it could provide a large new market for bromine.[12]

Michigan Chemical Corp., opened a new technical center at Ann Arbor, Mich., in which development work will be conducted on new products, production methods, and quality control.

A new bromine chapter of the Bureau of Mines publication, Mineral Facts and Problems, was written in 1975; it covers such aspects as industry structure, supply and demand, etc., and predicts demand for bromine to the year 2000.[13]

[10] Industrial Minerals. Company News & Mineral Notes. No. 95, August 1975, p. 49.
[11] Industrial Minerals Israel. Bromine and Phosphate For Europe. No. 102, March 1976, p. 10.
[12] Chemical Engineering. Bromine Chloride: Less Corrosive Than Bromine. V. 80, No. 18, Aug. 6, 1973, pp. 102–106.
[13] Klingman, C. L. Bromine. Ch. in Mineral Facts and Problems. BuMines Bull. 667, 1976, 10 pp.

Cadmium

By Ronald J. DeFilippo [1]

In 1975 cadmium metal production in the United States declined for the third consecutive year with output at the lowest level since 1938. Apparent consumption reached the lowest level since 1940. Imported cadmium metal, not including the cadmium content of imported flue dusts and zinc concentrates, provided 41% of the total U.S. supply, compared with 26% in 1974. There were no sales of government stockpile excesses by the General Services Administration (GSA).

Seven plants and six companies accounted for the total domestic primary production. The producer price decreased from $4.25 per pound at the beginning of the year to $2.00 at yearend.

Legislation and Government Programs.—There were no sales of cadmium by GSA in 1975 from national stockpile excesses. At yearend the total inventory stood at 3,233 tons. The stockpile objectives remained at 2,223 tons, and the quantity available for public disposal was 227 tons. Exploration assistance for cadmium was offered by the Office of Minerals Exploration, with 50% of allowable costs furnished by government participation. No contracts were sought or active in 1975. Depletion allowances were 22% for domestic mines and 14% for mines in foreign countries.

Table 1.—Salient cadmium statistics
(Short tons)

	1971	1972	1973	1974	1975
United States:					
Production [1]	3,965	4,145	3,751	3,333	2,193
Shipments by producers [2]	3,887	5,240	4,304	3,250	818
Value ... thousands	$9,823	$18,965	$23,891	$21,405	$4,167
Exports	33	509	153	31	198
Imports for consumption, metal	1,749	1,211	1,948	1,985	2,618
Apparent consumption	5,436	6,313	6,267	6,050	3,341
Price: Average per pound [3]	$1.92	$2.56	$3.64	$4.09	$3.36
World: Production	17,007	18,371	r 18,925	r 19,038	16,906

r Revised.
[1] Primary and secondary cadmium metal. Includes equivalent metal content of cadmium sponge used directly in production of compounds.
[2] Includes metal consumed at producer plants.
[3] Average quoted price for cadmium sticks and balls in lots of 1 to 5 tons.

DOMESTIC PRODUCTION

Domestic cadmium metal production was 483 tons in the first quarter, increased to 621 tons in the second quarter, and declined in the fourth quarter to 587 tons. Total cadmium metal production for the year was 2,193 tons, down 34% from that of 1974. Metal production was nearly three times greater than metal shipments, which were 75% below those of 1974.

Cadmium sulfide production (including cadmium sulfoselenide and lithopone) declined 9% from that of 1974; this was only about one-fourth the rate of decline for metal production.

Smelter recovery of cadmium averaged about 10 pounds of cadmium per ton of slab zinc produced, nearly the same as in 1974.

Cadmium oxide was produced by two of the seven primary metal producing plants. One plant reported secondary production, which was remelted metal or refined cadmium sponge.

[1] Physical scientist, Division of Nonferrous Metals.

Table 2.—Primary cadmium producers in the United States in 1975, by plant type and rank of output

Name and type of plant	Plant location
Electrolytic plants:	
Amax Zinc Co. Inc	Sauget, Ill.
ASARCO, Inc	Corpus Christi, Tex.
Bunker Hill Co	Kellogg, Idaho.
Horizontal-retort plant:	
National Zinc Co	Bartlesville, Okla.
Vertical-retort plants:	
ASARCO, Inc	Denver, Colo.
St. Joe Minerals Corp	Josephtown, Pa.
New Jersey Zinc Co	Palmerton, Pa.

Table 3.—Cadmium sulfide[1] produced in the United States
(Short tons)

Year	Sulfide[2] (cadmium content)
1971	1,118
1972	1,357
1973	1,412
1974	1,085
1975	987

[1] Cadmium oxide withheld to avoid disclosing individual company confidential data.
[2] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

Actual consumption data are not gathered by the Bureau of Mines. The apparent consumption of cadmium, 3,341 tons, was 45% below that of 1974. Metal used for electroplating hardware used in transportation vehicles and stationary mechanical and electrical equipment accounted for slightly less than half of total domestic cadmium consumption. Cadmium compounds used for red, orange, and yellow pigments and other compounds used as plastics stabilizers accounted for an additional one-third of U.S. cadmium consumption. The remainder of consumption was accounted for by cadmium metal and compounds used in alloys, nickel-cadmium batteries, and specialized electronics devices.

Table 4.—Supply and apparent consumption of cadmium
(Short tons)

	1974	1975
Stocks—beginning	1,326	1,569
Production	3,333	2,193
Imports, metal	1,985	2,618
Government sales	1,006	--
Total (supply)	7,650	6,380
Exports	31	198
Stocks—end	1,569	2,841
Apparent consumption[1]	6,050	3,341

[1] Total supply minus exports and yearend stocks.

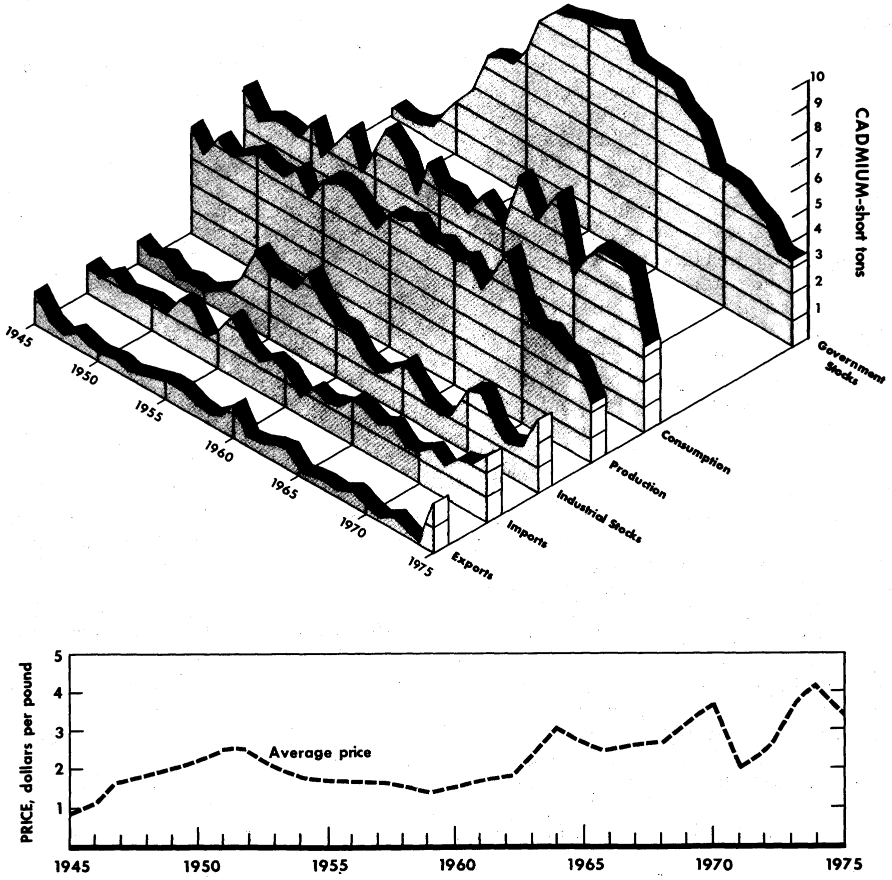

Figure 1.—Trends in production, consumption, yearend stocks, exports, imports, and average price of cadmium metal in the United States.

STOCKS

Stocks of cadmium metal held by metal producers at the end of 1975 increased threefold to 2,073 tons, reflecting the continued softening market for cadmium metal. The metal stocks of compound manufacturers declined 19%.

Table 5.—Industry stocks, December 31
(Short tons)

	1974		1975	
	Cadmium metal	Cadmium in compounds	Cadmium metal	Cadmium in compounds
Metal producers	698	W	2,073	W
Compound manufacturers	165	529	133	388
Distributors	136	41	213	34
Total	999	570	2,419	422

W Withheld to avoid disclosing individual company confidential data; included with "Compound manufacturers."

PRICES

The producer price for cadmium was $4.25 per pound at the beginning of the year. On June 6, National Zinc Co. cut prices, leading to a cadmium quote of $3 per pound by the end of June by all dealers. In September there was another round of price reductions with St. Joe Minerals Corp. taking the lead. By September 17 all U.S. producers were quoting a price of $2.50 per pound. On December 2 St. Joe cut the cadmium price to $2 per pound, and the other primary producers quickly followed. This was the lowest price for cadmium since January 1972.

Domestic dealer prices started the year at around $2.60 per pound and held at this level until the June producer price cut. Dealer prices then began to decline, to about $2.30 per pound by the end of September and to $1.85 to $1.90 by yearend. European dealer prices were considerably under U.S. dealer prices at the beginning of the year, but by yearend the two prices were identical.

Table 6.—Cadmium prices, 1975
(Dollars per pound)

Date	Producer price, 1- to 5-ton lots
Jan. 1 to June 6	4.25
June 6 to June 26	3.00–4.25
June 26 to Sept. 9	3.00
Sept. 9 to Sept. 17	2.75–3.00
Sept. 17 to Dec. 1	2.50
Dec. 1 to Dec. 8	2.00–2.50
Dec. 8 to Dec. 31	2.00

FOREIGN TRADE

Exports of cadmium metal and scrap increased from 31 tons in 1974 to 198 tons in 1975. The principal recipient countries were Belgium, 54%; the Netherlands, 30%; and Japan, 7%.

Imports of cadmium metal were up 32% over those of 1974. Belgium-Luxembourg was the largest supplier of metal with 23% of the total, followed by Australia, 15%; Canada, 11%; West Germany, 9%; Zaire, 8%; Mexico, 8%; Peru, 7%; and Spain, 5%. Mexico, the sole foreign supplier of cadmium-containing flue dust, more than doubled its exports to the United States in 1975 compared with 1974.

Table 7.—U.S. exports of cadmium metal and cadmium in alloys, dross, flue dust, residues and scrap

Year	Quantity (short tons)	Value (thousands)
1973	153	$598
1974	31	238
1975	198	589

Table 8.—U.S. imports for consumption[1] of cadmium metal and cadmium flue dust, by country

Country	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Cadmium metal:				
Australia	385	$2,953	398	$2,006
Austria	7	51	5	35
Belgium-Luxembourg	249	1,818	603	3,544
Brazil	--	--	6	22
Canada	647	4,775	279	1,611
Congo	--	--	17	103
Finland	--	--	4	21
France	6	42	81	428
Germany, West	39	275	225	1,091
Hong Kong	(2)	2	--	--
Japan	15	104	--	--
Korea, Republic of	60	450	55	259
Mexico	239	1,883	214	1,359
Netherlands	14	106	68	304
New Zealand	7	63	--	--
Panama	18	32	--	--
Peru	142	1,057	178	843
Poland	47	274	17	89
South Africa, Republic of	11	88	--	--
Spain	16	100	120	507
U.S.S.R	11	68	--	--
United Kingdom	14	116	55	265
Yugoslavia	58	417	77	406
Zaire	--	--	216	1,009
Total	1,985	14,674	2,618	13,902
Flue dust (cadmium content): Mexico	166	603	346	1,489
Grand total	2,151	15,277	2,964	15,391

[1] 1974 and 1975 general imports and imports for consumption were the same.
[2] Less than ½ unit.

WORLD REVIEW

World smelter production of cadmium was 11% below that of 1974. Japan and the United States were the largest cadmium producers with 17% and 13%, respectively, of the world total. Following in percentage of production were Canada, 8%; West Germany, 7%; Belgium, 6%; and the 23 remaining producing countries, 49%. Apparent consumption in the United States was 19.8% of the world production.

New zinc smelters and expansion plans that were underway and scheduled for completion by 1976 in India, Japan, Mexico, and the United States would raise world zinc production capacity by about 260,000 tons. Based on an optimal estimated recovery ratio of 10 pounds of cadmium per short ton of slab zinc production, this increase could provide a potential for about 1,300 tons of additional cadmium production compared with 1974 capacity.

European and Japanese cadmium producers formed the International Cadmium Institute (Incadin) at Brussels, Belgium, in March and held their first working meeting in June. The objectives of Incadin were to collect and distribute information on cadmium usage and to stimulate cadmium consumption.

Table 9.—Cadmium: World smelter production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Canada (refined)	[r] 1,542	1,370	1,342
United States [2]	3,751	3,333	2,193
Latin America:			
Mexico	201	581	646
Peru	252	201	[e] 220
Europe:			
Austria	32	29	[e] 30
Belgium	1,264	1,150	1,065
Bulgaria [e]	220	220	220
Finland	197	172	239
France	668	710	[e] 715
Germany, East [e]	[r] 20	[r] 20	22
Germany, West	1,346	1,476	1,121
Italy	438	527	[e] 500
Netherlands [e]	34	[r] 105	105
Norway	97	99	[e] 65
Poland [e]	390	390	390
Romania	88	99	[e] 100
Spain	150	196	[e] 200
U.S.S.R. [e]	2,750	[r] 2,860	2,920
United Kingdom	346	309	[e] 345
Yugoslavia [e]	165	260	220
Africa:			
South-West Africa [3]	[r] 144	139	[e] 105
Zaire	306	299	291
Zambia	[r] 17	14	[e] 15
Asia:			
China, People's Republic of [e]	110	120	120
India	36	65	60
Japan	[r] 3,494	3,337	2,929
Korea, North [e]	120	120	120
Oceania: Australia	747	837	608
Total	[r] 18,925	19,038	16,906

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Table gives unwrought metal production from ores, concentrates, flue dusts, and other materials of both domestic and imported origin. Sources generally do not indicate if secondary metal (recovery from scrap) is included or not; where known this has been indicated by footnote. Data derived in part from World Metal Statistics (published by World Bureau of Metal Statistics, London) and from Metal Statistics (published by Metallgesellschaft Aktiengesellschaft, Frankfurt am Main). Cadmium is produced in ores, concentrates, and/or flue dusts in a number of other countries, but these materials are exported for treatment elsewhere to recover cadmium metal; therefore, such output is not recorded in this table to avoid double counting.

[2] Includes secondary.

[3] Output of Tsumeb Corp. for calendar years.

TECHNOLOGY

As in past years, there was continued interest in abating environmental cadmium dispersal. Several processes were devised to remove cadmium from industrial effluent. One process utilizes a reagent such as sodium sulfide, ammonium polysulfide, or hexanethiol, the effluent and reagent are passed through peat, on which the insoluble metal sulfide precipitates for later recovery as an oxide by drying and furnace oxidation of the peat.[2] Another method utilizes algae of the genus *Chlorella* to extract cadmium from wastewater. It was found that cadmium levels were reduced from 200 parts per million (ppm) to 8.6 ppm.[3] A third method uses aldehyde-dithiocarbamate or aldehyde-dithiocarbamate-aromatic compounds to selectively adsorb heavy metals such as cadmium and zinc.[4] A fourth method of wastewater treatment utilizes ground coral to absorb cadmium and other heavy metal ions. The exhausted material can then be dried and used as an aggregate or regenerated by chemical or thermal methods with recovery of the cadmium.[5]

One study of atmospheric dispersal of cadmium and other trace metals suggested that much or all of the high cadmium levels observed over the North Atlantic were from natural sources.[6]

The geochemical dispersal patterns of zinc and cadmium were studied in reservoir sediments downstream from mine workings; it was found that the heavy metals tended to concentrate in the deepest sediments.[7] The behavior of cadmium and other metals was investigated in a marine estuary at Back River, Md. It was found that within 1.2 to 1.9 miles of a wastewater treatment plant outfall the cadmium concentration dropped from 3.5 milligrams per liter (mg/1) to 0.5 mg/1 as the cadmium precipitated. However, cadmium concentration increased downstream, presumably as conditions changed and the cadmium reentered solution.[8]

The sources and pathways by which cadmium is consumed by humans were also investigated. Cadmium levels which are considered hazardous were also discussed.[9]

The toxicology of cadmium was explored in a review of the biological and biochemical effects of the metal and its compounds with a summary of the methods for monitoring cadmium exposure.[10] Health and safety precautions were also outlined in an article which suggested that the threshold limit for cadmium metal and soluble salts in the air should be 0.2 milligram per cubic meter (mg/m^3), and for soluble cadmium fume in air, 0.1 mg/m^3.[11]

A report was published by the Environmental Protection Agency (EPA) that explored (1) present real dangers to man and the environment, (2) sources of cadmium entering the environment, (3) control alternatives that may be technologically and legally feasible, and (4) the present and projected role of cadmium in the U.S. economy and the impact of proposed control measures. It was found that there was no definite correlation between cadmium dissemination and chronic diseases. Also it was found that of the total amount of cadmium released by man, 20% is accountable to the primary nonferrous metals industry (mining and smelting); 30% is due to the conversion, use, and disposition of cadmium; and the remaining 50% is inadvertent (for example, from fossil fuels, fertilizers, and sewage sludge). It was concluded that only 15% of cadmium emissions are in the form of air pollution; the remainder is in land-destined wastes, only 10% of which are in concentrations greater than 0.1%.[12]

Overcoming problems associated with the cadmium plating of steel was the subject of several studies. The addition of

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[2] Université de Sherbrooke. Removal and Recovery of Metals From Polluted Waters. Brit. Pat. 1,382,898, Feb. 5, 1975.

[3] Hitachi, Ltd. Method of Treating Wastewater. Brit. Pat. 1,395,462, May 29, 1975.

[4] Nippon Soda Co., Ltd. Adsorbent for Heavy Metallic Substances, and Method of Adsorbing Such Substances. Brit. Pat. 1,395,463, May 29, 1975.

[5] Kajiyama, Y. Process for Removing Heavy Metal Ions. Brit. Pat. 1,387,552, Mar. 19, 1975.

[6] Druce, R. A., G. L. Hoffmann, and W. H. Zoller. Atmospheric Trace Metals at Remote Northern and Southern Hemisphere Sites: Pollution or Natural? Science, v. 87, No. 4171, Jan. 19, 1975, pp. 59–61.

[7] Pita, F. W., and N. J. Hyne. The Depositional Environment of Zinc, Lead, and Cadmium in Reservoir Sediments. Water Research (United Kingdom), v. 9, No. 8, August 1975, pp. 701–706.

[8] Helz, G. R., R. J. Huggett and J. M. Hill. Behavior of Mn, Fe, Zn, Cd, and Pb Discharged From a Wastewater Treatment Plant Into an Estuarine Environment. Water Research (United Kingdom), v. 9, No. 7, July 1975, pp. 631–636.

[9] Webb, M. Cadmium. British Medical Bull. (United Kingdom), v. 31, No. 3, September 1975, pp. 246–252.

[10] Buell, G. Some Biochemical Aspects of Cadmium Toxicology. J. Occupational Medicine, v. 17, No. 3, March 1975, pp. 189–195.

[11] Health and Safety Executive. Cadmium. Health and Safety Precautions. H. M. Factory Inspectorate (London), Tech. Data Note 11, 1975, 3 pp.

[12] Environmental Protection Agency. Technical and Microeconomic Analysis of Cadmium and Its Compounds. EPA 560/3–75–006, June 1975, 203 pp.

sodium carbonate to the plating bath was found to reduce the dissolution of the cadmium deposit.[13] Another study found that a plating current density of 22 amperes per square foot was the optimum value for titanium-cadmium plating.[14] One firm adopted a mechanical plating process for its entire plated production. The particular process, developed and owned by the Minnesota Mining and Manufacturing Co., avoids electroplating embrittlement problems and is virtually pollution-free.[15]

Electrodeposits of a cadmium alloy containing 14% gold and 11% copper could be used as a reliable electrical contact material.[16]

Beryllium, tin, and cadmium (1.1%) added to a white metal bearing alloy were found to substantially increase the mechanical strength of the alloy.[17]

A photoconductive material comprised of fine cadmium sulfide and cadmium carbonate particles on a silicate base was found to have good performance under conditions of high ambient temperature and humidity.[18]

A method of manufacturing a negative battery electrode with a cadmium powder-cadmium oxide slurry applied to a nickel screen was developed. The cell has a desired amount of precharge even in an uncharged condition.[19] Another method makes electrodes by sintering nickel powder with anhydrous cadmium fluoride or potassium cadmium fluoride for use with an alkaline electrolyte.[20] Lead-acid and nickel-cadmium batteries were compared for ampere-hour efficiencies and were quoted at 90% and 72%, respectively.[21]

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13 Altura, D., and F. Mansfield. Effect of Plating Conditions on Performance of Porous Cadmium Deposit. Corrosion, v. 31, No. 6, June 1975, pp. 214–218.

14 Altura, D., and F. Mansfield. Effect of Plating Current Density on Properties of Ti-Cd Deposit. Corrosion, v. 31, No. 7, July 1975, pp. 234–236.

15 Industrial Finishing and Surface Coating. Better Fastener Quality With Mechanical Plating. V. 51, No. 5, 1975, pp. 44–46.

16 Mason, D. R., A. Blair, and P. Wilkinson. Have Gold Deposits Any Industrial Application? Galyano-Organo (France), No. 457, September 1975, pp. 651–655.

17 Quarterly Review. Tin Research Institute. Tin and Its Uses. A new White Metal Bearing Alloy. No. 103, 1975, pp. 1–10.

18 Fuji Photo Film Co., Ltd. Process of Making a Photoconductive Material of Cadmium Sulfide and Cadmium Carbonate. U.S. Pat. 3,867,139, Feb. 18, 1975.

19 General Electric Co. Rechargeable Cell With Cadmium Anode. Brit. Pat. 1,383,282, Feb. 12, 1975.

20 Centre Nationale D'Etudes Spatiales. Method of Producing Primary or Secondary Battery Electrodes. Brit. Pat. 1,383,957, Feb. 12, 1975.

21 Prescott, A. Batteries—The Ultimate Standby Power Source. Electronics Rev. (United Kingdom), v. 196, No. 7, Feb. 21, 1975, pp. 217–220.

Calcium and Calcium Compounds

By Avery H. Reed [1]

Calcium metal was manufactured by one company in Connecticut. Calcium chloride was produced by two companies in California and three companies in Michigan. Synthetic calcium chloride was manufactured by three companies in New York and Washington.

DOMESTIC PRODUCTION

Pfizer Inc. produced calcium metal at Canaan, Conn., by the Pidgeon process, in which quicklime and aluminum powder are heated in vacuum retorts; at a temperature of 1,170° C, calcium vaporizes and it is collected at one end of the retort.

National Chloride Co. of America and Leslie Salt Co. produced calcium chloride from wells in San Bernardino County, Calif. Output declined 13%. The Dow Chemical Co., Michigan Chemical Corp., and Wilkinson Chemical Corp. recovered calcium chloride from brine, in Gratiot, Lapeer, Mason, and Midland Counties, Mich. Output declined 20%. Total production of natural calcium chloride was 594,000 tons, 20% below the 1974 record.

Allied Chemical Corp. recovered synthetic calcium chloride as a byproduct of soda ash at Syracuse, N.Y.; Reichold Chemicals, Inc. recovered synthetic calcium chloride as a byproduct of pentachlorophenol manufacture at Tacoma, Wash.; and Hooker Chemicals & Plastic Corp. manufactured calcium chloride at Tacoma using limestone and hydrochloric acid. Total output of synthetic calcium chloride was 234,000 tons.

The total value of all calcium chloride sold in 1974 was a record high of $44 million.

CONSUMPTION AND USES

Calcium metal was used as a reducing agent to separate metals such as columbium, tantalum, thorium, titanium, uranium, vanadium, and zirconium from their oxides; to form alloys with aluminum, lead, lithium, magnesium, and silicon; as a scavenger in the steel industry; and in the manufacture of calcium hydride. A potentially important use for calcium metal is in a new storage battery that requires no water to be added.

The principal use for calcium chloride was to melt snow and ice from roads, streets, bridges, and pavements. Calcium chloride is more effective at lower temperatures than is rock salt and is mainly used in the northern and eastern States. It was also used to keep down dust on roads and driveways, and as an accelerator for concrete.

PRICES AND SPECIFICATIONS

Prices for calcium metal ranged from $1 to $5 per pound. Calcium chloride is usually sold either as solid flake or pellet averaging about 75% $CaCl_2$, or as a concentrated liquid averaging about 40% $CaCl_2$. On a 75% basis, the average value in 1975 for natural calcium chloride was $48.87 per ton; and the average value for synthetic calcium chloride was $64.72 per ton.

[1] Supervisory physical scientist, Division of Nonmetallic Minerals.

FOREIGN TRADE

Exports of calcium chloride, mainly to Canada and Mexico, totaled 28,400 tons valued at $2,314,000, compared with 30,900 tons valued at $1,699,000 in 1974. Exports of dicalcium phosphate were 21,100 tons valued at $6,270,000; leading destinations were Canada, Taiwan, and Thailand. Exports of precipitated calcium carbonate, mainly to Canada and Mexico, were 4,640 tons valued at $705,000.

Total imports of calcium and calcium compounds were 228,300 tons valued at $17,530,000. Imports of calcium metal from Canada, the U.S.S.R., and France totaled 35 tons valued at $77,700. Imports of calcium chloride, mainly from Canada, were 12,000 tons valued at $598,000. Imports of other calcium compounds, mainly from Norway, Canada, Turkey, and France totaled 216,200 tons, valued at $16,850,000.

Imports of other calcium compounds included 94,950 tons of calcium nitrate from Norway, Canada, Sweden, the United Kingdom, and New Zealand; 57,420 tons of calcium cyanamide from Canada and West Germany; 27,640 tons of calcium borate from Turkey and Sweden; 20,120 tons of whiting from France, the United Kingdom, Belgium, and Switzerland; 5,440 tons of calcium carbide from Canada; 1,563 tons of precipitated calcium carbonate from the United Kingdom, Japan, Canada, West Germany, and the Netherlands; 1,379 tons of calcium hypochlorite from Japan; 1,040 tons of calcium cyanide from Canada and Mexico; and 6,656 tons of other compounds, mainly from the United Kingdom, Canada, and West Germany.

Table 1.—U.S. imports for consumption of calcium and calcium chloride

Year	Calcium		Calcium chloride	
	Quantity (pounds)	Value	Quantity (short tons)	Value
1971	48,391	$29,751	13,019	$543,656
1972	248,080	181,437	6,128	225,463
1973	110,407	77,864	7,357	317,007
1974	109,252	120,883	3,599	155,727
1975	70,128	77,684	12,021	597,758

Table 2.—U.S. imports for consumption of calcium chloride in 1975, by country

Country	Quantity (short tons)	Value
Belgium-Luxembourg	22	$2,037
Canada	11,378	302,523
France	7	5,019
Germany, West	43	5,480
Japan	551	273,625
United Kingdom	20	9,074
Total	12,021	597,758

WORLD REVIEW

Canada.—Chromasco Corp. Ltd. produced calcium metal at its Haley smelter near Renfrew, Ontario. Canada continued to lead all other countries in the production of calcium metal. About 25 tons valued at $51,000 was exported to the United States. Canada was the leading source of U.S. imports of calcium chloride.

France.—Planet Wattohm S.A., a subsidiary of Compagnie de Mokta, produced calcium metal by the Pidgeon process. About 3 tons valued at $15,000 was exported to the United States.

U.S.S.R.—Some calcium metal was produced in the U.S.S.R. Seven tons of Soviet calcium metal valued at $12,000 was exported to the United States.

TECHNOLOGY

The use of calcium metal could increase if the new "maintenance free" automotive batteries prove to be a commercial success. These batteries use calcium-lead alloy instead of antimonial-lead alloy. They are hermetically sealed and require no addition of water during the life of the battery.

Carbon Black

By Herbert L. Franklin [1]

The carbon black industry is heavily dependent on one industrial sector; namely, rubber manufacturing. Since 1950, the rubber industry has consumed, on the average, 94% of all carbon black output. This trend continued in 1975. During the year rubber manufacturers, suffering a 10% reduction in sales because of the general economic recession, cut back carbon black purchases by 12.7%. This figure corresponds very closely with the average drop in domestic carbon black sales of 13.3%. However, the overall drop in carbon black sales was aggravated somewhat by even greater cutbacks in consumption by a group of small-scale users including the chemical, food, metallurgical, and plastics processing industries.

Following the trend of reduced sales, production also dropped sharply in 1975; output was only about four-fifths that of 1974. During this off year, plant expansion was minimal and an overall drop of about 4% in productive capacity occurred; the only significant shutdown reported was the closing of Cabot Corp.'s thermal facilities at Franklin, La.

Greater use of the oil furnace process was reflected in the increased proportion of oil furnace blacks processed during 1975; production increased from approximately 83% of the total output in 1974 to nearly 87% during 1975. The increased share of oil furnace blacks took place at the expense of Semireinforcing Furnace black (SRF) and thermal black grades. The largest proportionate drop occurred in thermal blacks, which declined from 8% of the 1974 total to 4.4% of the 1975 output, reflecting, in part at least, the loss of Cabot thermal production at Franklin, La.

Although the average yields from liquid hydrocarbons dropped slightly during 1975 and average output from natural gas increased, the trend toward greater proportional use of liquid hydrocarbons continued. In 1974, liquid hydrocarbons accounted for 94.7% of total output, and in 1975, they accounted for 95% of U.S. production. This trend is easily explained in terms of cost as the average cost of carbon black produced from liquid hydrocarbons in 1975 was 5.16 cents per pound and that from natural gas was 13.38 cents per pound.

Shipments continued the downward trend begun in 1974 and plunged to 2,804 million pounds, the industry's lowest level since 1969. Movements to foreign consumers dropped to an even greater degree than to domestic buyers; in 1974 exports accounted for 5.8% of all carbon black shipments while in 1975 they made up only 3.1% of the total. Imports, totaling 33.5 million pounds, were up about 11% over the 1974 level. The principal sources of these imported carbon blacks in order of significance were Canada, Indonesia, and West Germany accounting for 86%, 10%, and 3.5%, respectively; the remainder came from other West European countries and Kenya. Small amounts of lampblack were imported from West Germany and Indonesia, and a very small quantity of bone black was purchased from Canada.

Carbon black prices increased from an average of 11.87 cents per pound in January 1975 to 12.75 cents per pound in April or about 7.4%. By June 1975, the depressed carbon black market forced prices for most grades back down to their January 1975 levels. The only exception was thermal blacks, which retained their average post-April levels of 12 cents per pound. Channel blacks held their January

[1] Mineral specialist, Division of Petroleum and Natural Gas.

prices throughout the year. Producers being squeezed between escalating production costs and a depressed market looked for means other than price increases to retain their profit margins or reduce losses; to accomplish this, many focused attention on cost reduction through improved operating efficiency, particularly by lowering energy consumption.

Table 1.—Salient statistics of carbon black produced from liquid hydrocarbons and natural gas in the United States
(Thousand pounds)

	1971	1972	1973	1974	1975
Production:					
Channel process	46,354	22,378	14,222	W	W
Furnace process	2,970,781	3,178,731	3,485,719	3,390,325	2,741,832
Total	3,017,135	3,201,109	3,499,941	W	W
Shipments (including losses):					
Domestic	2,853,948	3,148,114	3,314,646	r 1 3,147,980	2,729,772
Exports	163,246	111,238	192,665	r 1 192,970	1 74,268
Total	3,017,194	3,259,352	3,507,311	r 1 3,340,950	1 2,804,040
Producer stocks Dec. 31	296,028	237,785	230,415	1 293,903	1 231,695
Value:					
Production - thousand dollars	$232,049	$248,361	$284,153	$372,281	$306,373
Average per pound --- cents	7.69	7.76	8.12	10.98	11.17

r Revised. W Withheld to avoid disclosing individual company confidential data.
1 Excludes channel black.

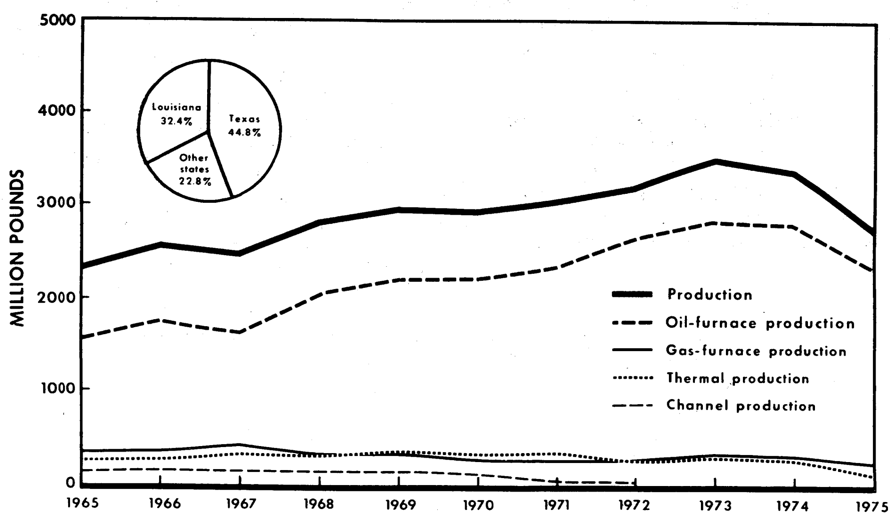

Figure 1.—U.S. production by process and geographic area.

PRODUCTION AND CAPACITY

Production by State.—Carbon black production, totaling 2,742 million pounds plus an undisclosed amount produced by the channel process, dropped sharply from the 3,390 million pounds in 1974. This drastic reduction of approximately 19% was attributable in general to the economic recession and most notably to the decline in demand for automobile tires. Production facilities in Texas and Louisiana, near sources of energy and feedstocks, accounted for about 77% of the national production. The remaining domestic output came from Arkansas, California, Kansas, Ohio, Oklahoma, and West Virginia.

Production by Grade and Type.—Carbon black was produced principally by furnace combustion processes, which accounted for 95.6% of reported national production; the remainder was produced by thermal cracking methods. An undisclosed but presumably small quantity of channel black was also produced during the year. The channel production process has been declining steadily in importance and in 1973, the last year for which data are available, accounted for less than 1% of total output. The declining significance of the channel process can be attributed principally to relatively low yields and rising gas prices; however, the low priority assigned to natural gas for use as a raw material in carbon black manufacturing can also be considered a significant contributing factor. High Abrasion Furnace (HAF), General Purpose Furnace (GPF), and Fast Extruding Furnace (FEF) blacks together accounted for 78% of national production; notably, all of these grades are derived from liquid hydrocarbons. The finer particle Intermediate Superabrasion Furnace (ISAF) and Superabrasion Furnace (SAF) grades, also processed from liquid hydrocarbons, made up 8.8% of total production. SRF and the relatively coarse thermal blacks, both based on natural gas feedstocks, declined in significance as their combined share of total output decreased from 17.3% in 1974 to 13.3% in 1975.

Number and Capacity of Plants.—During 1975, 32 carbon black plants were operating in the United States. All but one were furnace black facilities, the other was a channel black plant. Total daily production capacity of furnace black plants dropped to 11.16 million pounds, a decrease of 4.2% from reported capacity of 1974. The reduction in daily output capability can be partially explained by the closing of Cabot Corp.'s thermal processing capacity at Franklin, La. The remaining capacity reduction can only be attributed to changes in feedstock mixes and product output.

Although aggregate figures indicated a net drop in productive capacity, additional capacity was added at a few plants. Phillips Petroleum Co. completed expansion activities at its production facilities in Borger and Orange, Tex., and at Toledo, Ohio. The expansions added approximately 156,000 pounds of daily throughput capacity to Phillips domestic facilities. Other development activities in the carbon black industry focused mainly on developing alternate fuels capability, reducing energy consumption, and other measures to improve operating efficiency.

Materials Used and Yields.—During 1975, liquid hydrocarbons increased their dominance as a feedstock for production of carbon black. About 517.4 million gallons of liquid hydrocarbons were used to manufacture 2,606 million pounds of carbon black or 95% of the total domestic output. Natural gas continued its decline in significance as quantities used were 35% less than in 1974; about 26.2 million cubic feet were consumed in producing 136 million pounds of carbon black. Yields from liquid hydrocarbons dropped slightly to 5.04 pounds per gallon, interrupting the increasing trend that has prevailed for the past 5 years. Conversely, yields from natural gas increased to 5.19 pounds per thousand cubic feet in 1975, after a significant drop in average output during the preceding year. Another significant trend to follow when comparing the two types of raw materials used is the relative cost of each input. The average cost of liquid hydrocarbons for each pound of carbon black production increased from 1.73 cents in 1973 to 5.16 cents in 1975. Natural gas costs ranged from 4.88 cents per pound in 1973 to 13.38 cents per pound in 1975.

CONSUMPTION AND USES

The carbon black industry, heavily dependent on rubber production for its survival, continued its dependency as sales to the rubber industry amounted to 93.6% of total sales in 1975. Varying amounts and grades of carbon black are used for the many parts of a tire depending on the qualities needed; overall, carbon black makes up about one-fourth of a tire's total weight. Passenger vehicle tires contain 6 to 7 pounds each and truck tires require about 20 pounds per tire. A significant amount of carbon black is also used in a large number of other rubber products such as hoses and belts needed by the automotive and other industrial sectors. The remaining carbon black sales in 1975 were spread over a number of industries including ink, paint, paper, chemical, food, metallurgical, and plastics. Because of the general economic recession that continued into 1975, total domestic sales of carbon black dropped about 13% below the level of 1974. This overall decline corresponds closely with the reduction in sales to rubber manufacturers, but substantially sharper drops in demand by some of the smaller consumers aggravated the carbon black sales situation slightly.

STOCKS

At the close of 1975, producer's stocks had dropped to 231.7 million pounds, about 21% less than the 1974 yearend level. This figure approximates the yearend inventory levels of 1972 and 1973. Channel black stocks held at yearend were not reported.

A significant drawdown occurred in each grade of carbon black except the ISAF blacks, which increased 2%. The largest depletions occurred in the thermal stocks, which dropped nearly 50%, and the supply of FEF blacks, which was 48% lower than at the beginning of 1975. The HAF blacks, most active in trading with 43% of the shipments reported during the year, also retained the largest inventory at yearend, or 41% of all carbon black stocks on hand.

FOREIGN TRADE

Exports of carbon black, as reported by the Bureau of Census, dropped to 87.9 million pounds in 1975. About 40% of the U.S. exports went to Europe where the United Kingdom, France, and West Germany were the principal recipients. North American consumers, principally Canada and Mexico, received nearly one-fourth, and Asian countries purchased about 21% of the total.

Carbon black imports totaled approximately 33.5 million pounds in 1975. Almost 86% of these came from Canada, and 10%, from Indonesia. The remainder came mostly from West European producers. The United States also imported 69,300 pounds of bone black from Canada during the year and 377,518 pounds of lampblack from Indonesia and West Germany.

Exported carbon blacks averaged 17.6 cents per pound in 1975 compared to 12.5 and 16.3 cents per pound in 1973 and 1974, respectively. Imported carbon blacks cost U.S. consumers an average price of 12.97 cents per pound in 1975; comparative costs for 1973 and 1974 were 11.4 and 14.6 cents per pound, respectively. Imported bone blacks averaged 11.0 cents per pound, and lampblack was purchased at an average price of 41.2 cents per pound.

WORLD REVIEW

World production of carbon black decreased about 12% in 1975. Output dropped most sharply in the highly industrialized societies of the United States, and Western Europe. Productivity remained fairly stable in Eastern Europe and even increased slightly in some developing countries of Latin America and the Far East. Despite relatively large decreases in production, the United States, Japan, and Western Europe continued their dominance of the world market, collectively accounting for about four-fifths of worldwide output.

Although worldwide demand for carbon black generally plummeted during 1975, expectation of an improved market in 1976 and continued but slow growth over the long term, induced some capacity expansion and new construction.

Most development activity took place in Latin America and in the Far East, thus reflecting the belief of some industry leaders that carbon black consumption will grow more rapidly in developing regions than in the well-established industrial markets. Presumably, as the developing regions prosper, their local demand for automobiles and associated rubber products, mining equipment, and industrial machinery, will grow more rapidly than that in the more stable, established industrial markets.

Demand remained high during the year in Brazil, and Companhia Petroquimica Brasileira increased the capacity of its São Paulo plant to 160 million pounds per year. Other Brazilian activities included construction of a 72.7-million-pound-per-year plant at Candeias and another facility of undisclosed capacity at Capuava, near São Paulo. In Mexico a 13.2-million-pound-per-year plant was completed at Salamanca, and plans were made to construct an 80-million-pound-per-year furnace black facility in Tampico; the Tampico facility will be completed in 1976. United Carbon of Venezuela is also expanding its production facilities. In the Far East, expansion or new construction was underway in the Republic of Korea, India, and Malaysia. The facility under construction at Durgapur, India, will have a throughput capacity of 17.5 million pounds per year; projected output capacity of the other plants is not known. During the year, a 6.6-million-pound-per-year plant was completed at Kurnell, Australia.

In the more industrialized foreign countries, development activities focused mainly on improving operating efficiency, particularly in the area of energy consumption. In one expansion activity, however, Cities Service Co.'s Columbian Div. was reportedly building a sixth production unit at its Hamilton, Ontario, furnace black plant. Ashland Chemical Co. closed a plant at Speyer, West Germany.

TECHNOLOGY

Carbon black, a petrochemical, is an extremely fine soot, primarily carbon (90% to 99%), that contains some hydrogen and oxygen. Oil furnace black may also contain small amounts of sulfur. Properties of carbon black are determined largely by the process of manufacture. Furnace black, which accounts for 99% of all carbon black produced, is made by three different processes—gas furnace, oil furnace, and thermal. Oil furnace processes accounted for 87% of all furnace black output in the United States during 1975; gas furnace production made up 9%, and thermal output dropped to 4% of the total. Brief descriptions of these processes, the channel process, and the manufacture of lampblack follow.

Gas Furnace.—The gas furnace process is based on partial combustion of natural gas in refractory-lined furnaces. Carbon black is removed by flocculation and high-voltage electric precipitators. Yields of gas furnace blacks range from 10% to 30% and are lowest for the smaller particle-size grades. Properties of gas furnace blacks can be modified to a degree by changing the ratio of air to gas. High-Modulus Furnace (HMF) and SRF grades are generally produced from gas.

Oil Furnace.—Liquid hydrocarbons are used in the oil furnace process. Natural gas is generally burned to furnish the heat of combustion, and atomized oil is introduced into the combustion zone to be burned to various grades of carbon black. Yields range from 35% to 65%, depending on the grade of black produced. Oil furnace grades are FEF, GPF, HAF, ISAF, and SAF.

The most desirable feedstock oil for furnace black plants has 0° to 4° API gravity, is low in sulfur, and is high in aromatics and olefins. It comes from near the "bottom of the refinery barrel" and is similar in many respects to residual fuel oil. Rising costs of natural gas have influenced the shift to a greater use of liquid feedstocks and a corresponding decline in the use of natural gas as a source of carbon. Oil furnace processing has become highly flexible, supplementing channel blacks in most high-performance applications, notably passenger car tires. Carbon black technology centers on the oil furnace black process. One recent study concluded that by injecting oxygen or oxygen-enriched air into a furnace with a conventional burner, channel-type carbon black particles can be produced, and carbon black yields and energetic yields of combustion can be improved. However, it was noted that since the tests were carried out on a pilot scale, properties of the carbon black obtained might differ from those produced in an industrial plant.

Thermal.—Unlike channel and the gas and oil furnace blacks, thermal blacks are produced by cracking hydrocarbons; that is, by separating carbon from the hydrogen and not by the combustion of hydrocarbons. Thermal furnaces are built in a checkerboard brickwork pattern. Two refractory-lined furnaces, or generators, are used. One generator is heated using hydrogen as a fuel, while the other is charged with natural gas, which decomposes to produce thermal black and hydrogen. Hydrogen collected is used as fuel for the generator being heated. Yields of carbon black range from 40% to 50% and are primarily in the large particle sizes. This process has been declining in importance because of its dependence on high-cost natural gas as a feedstock and limited application of the large-sized particles produced by this method.

Channel Black.—Made by the oldest process, channel black is a product of incomplete combustion of natural gas. Small flames are impinged on cool surfaces, or channels, where carbon black is deposited and then scraped off as the channel moves back and forth over a scraper. Properties of channel black are varied by changes in burner tip design, distances from tip to channel, and the amount of air made available for combustion. The process is extraordinarily inefficient chemically. For rubber-reinforcing grades, the yield is only 5%; for high-color blacks of finer particle sizes, the yield shrinks to 1%. Low yields and rising gas prices have spurred the industry to develop other methods to make blacks.

Lampblack.—Lampblacks are manufactured by slowly burning selected oils and tars in a restricted supply of air. These blacks are of large particle size, possess little reinforcing ability in rubber, and are low in jetness and coloring power. They are of value as tinting pigments in certain paints and lacquers. In most applications lampblacks have been replaced by carbon blacks.

Carbon Black Substitutes.—Coal-derived carbon blacks have yet to be produced commercially, but several small companies are marketing carbon black extenders and fillers that are produced from anthracite and bituminous coals. These carbon black substitutes are used in rubber compounding and in the production of carbon paper, ink, paint, and plastics. Extenders (fillers from coal) are being utilized in conjunction with furnace carbon blacks, replacing thermal blacks.

New Technology.—Research into new technologies focused mainly on reclamation of carbon black from scrap tires. In one process, tires would be chemically decomposed by pyrolysis, and oil, steel, and carbon black components would be recovered; it is believed that an average of 5.7 pounds of carbon black can be recovered from each tire. A test-facility is to be set up by Goodyear Tire & Rubber Co. and The Oil Shale Corp. (TOSCO) at Rocky Flats, Colo., in 1976. If the process is successful, Goodyear plans construction of a scaled-up plant during 1977 that would produce about 63 million pounds of carbon black per year. In another process developed by Cities Service Co. and Goodyear, ground-up scrap tires are mixed with feedstock oil and burned in a limited amount of air to produce carbon black.

Table 2.—Carbon black produced from liquid hydrocarbons and natural gas in the United States, by State
(Thousand pounds)

	1971	1972	1973	1974	1975	Change from 1974 (percent)
Louisiana	1,078,732	1,077,977	1,207,708	1,192,795	887,719	−25.6
Texas	1,326,153	1,425,874	1,511,127	1,434,797	1,228,195	−14.4
Other States	612,250	697,258	781,106	762,733	625,918	−17.9
Total	3,017,135	3,201,109	3,499,941	[1]3,390,325	[1]2,741,832	−19.1

[1] Excludes channel black.

Table 3.—Production, shipments and stocks of carbon black in the United States in 1975, by grade

(Thousand pounds)

	SRF	GPF	FEF	HAF	SAF	ISAF	Thermal	Total[1]
Production	241,891	634,732	313,122	1,190,022	24,420	215,722	121,923	2,741,832
Shipments	248,825	639,231	329,747	1,203,717	25,392	215,071	142,057	2,804,040
Stocks: Dec. 31, 1975	22,177	35,449	17,975	94,785	7,863	32,959	20,487	231,695

[1] Excludes channel black to avoid disclosing individual company confidential data.

Table 4.—Number and capacity of furnace black plants operated in the United States

State	County or parish	Number of plants 1974	Number of plants 1975	Total daily capacity (pounds) 1974	Total daily capacity (pounds) 1975
Texas	Aransas	1	1	r 5,101,711	4,925,774
	Gray	1	1		
	Harris	1	1		
	Howard	2	2		
	Hutchinson	2	2		
	Montgomery	1	1		
	Moore	1	1		
	Orange	1	1		
	Terry	1	1		
	Wheeler	1	1		
Total Texas		12	12	r 5,101,711	4,925,774
Louisiana	Avoyelles	1	1	3,962,467	3,735,467
	Calcasieu	1	1		
	Evangeline	1	1		
	Ouachita	2	2		
	St. Mary	3	3		
	West Baton Rouge	1	1		
Total Louisiana		9	9	3,962,467	3,735,467
Alabama	Russell	1	--	2,585,339	2,499,143
Arkansas	Union	1	1		
California	Kern	3	3		
Kansas	Grant	1	1		
Ohio	Lucas	1	1		
	Washington	1	1		
Oklahoma	Kay	1	1		
West Virginia	Marshall	1	1		
	Pleasants	1	1		
Total other States		11	10	2,585,339	2,499,143
Total United States		32	31	r 11,649,517	11,160,384

Table 5.—Fuel and feedstocks used in carbon black production, by State [1]

		Louisiana	Texas	Other States [2]	Total
1974					
Carbon black production:					
Total	thousand pounds	1,192,795	1,434,797	762,733	3,390,325
Value	thousand dollars	$131,811	$155,603	$84,867	$372,281
Average value	cents per pound	11.05	10.84	11.12	10.98
Natural gas used:					
Total	million cubic feet	23,668	11,781	4,681	40,130
Value	thousand dollars	$9,299	$4,466	$2,637	$16,402
Average value	cents per thousand cubic feet	39.29	37.91	r 56.33	40.87
Carbon black produced	thousand pounds	141,344	22,736	17,059	181,139
Liquid hydrocarbons used:					
Total	thousand gallons	175,507	257,968	145,336	578,811
Value	thousand dollars	$44,614	$57,965	$35,622	$138,201
Average value	cents per gallon	25.42	22.47	24.51	23.87
Carbon black produced	thousand pounds	1,051,451	1,412,061	745,674	3,209,186
1975					
Carbon black production:					
Total	thousand pounds	887,719	1,228,195	625,918	2,741,832
Value	thousand dollars	$102,664	$134,946	$68,763	$306,373
Average value	cents per pound	11.56	10.98	10.98	11.17
Natural gas used:					
Total	million cubic feet	13,984	7,669	4,593	26,246
Value	thousand dollars	$9,733	$4,702	$3,803	$18,238
Average value	cents per thousand cubic feet	69.60	61.31	82.79	69.49
Carbon black produced	thousand pounds	105,906	19,081	11,279	136,266
Liquid hydrocarbons used:					
Total	thousand gallons	156,326	237,887	123,185	517,398
Value	thousand dollars	$42,184	$58,767	$33,577	$134,528
Average value	cents per gallon	26.98	24.70	27.25	26.00
Carbon black produced	thousand pounds	781,813	1,209,114	614,639	2,605,566

r Revised.
[1] Natural gas figures represent both fuel and feedstocks inputs to the production process.
[2] Arkansas, California, Kansas, Ohio, Oklahoma, and West Virginia.

Table 6.—Liquid hydrocarbons and natural gas used in manufacturing carbon black in the United States and average yield

		1971	1972	1973	1974	1975
Natural gas used	million cubic feet	63,699	53,939	49,682	40,130	26,246
Average yield of carbon black per thousand cubic feet	pounds	5.06	5.02	4.96	4.51	5.19
Average value of natural gas used per thousand cubic feet	cents	17.51	19.54	24.19	40.87	69.49
Liquid hydrocarbons used	thousand gallons	547,704	590,753	623,236	578,811	517,398
Average yield of carbon black per gallon	pounds	4.92	4.96	5.22	5.54	5.04
Average value of liquid hydrocarbons used per gallon	cents	7.96	8.13	9.03	23.87	26.00
Number of producers reporting		9	8	8	8	8
Number of plants		37	34	34	34	32

Table 7.—Sales of carbon black for domestic consumption in the United States, by use

(Thousand pounds)

Use	1971	1972	1973	1974	1975	Change from 1974 (percent)
Ink	75,201	82,532	84,364	83,009	72,326	−12.9
Paint	18,693	21,408	21,667	18,936	18,437	−2.6
Paper	3,767	4,225	4,212	3,604	4,241	+17.7
Rubber	2,678,151	2,953,779	3,114,565	2,925,032	2,553,778	−12.7
Miscellaneous [1]	77,715	84,764	88,786	115,939	80,675	−30.4
Total	2,853,527	3,146,708	3,313,594	3,146,520	2,729,457	−13.3

[1] Includes chemical, food, metallurgical, and plastics.

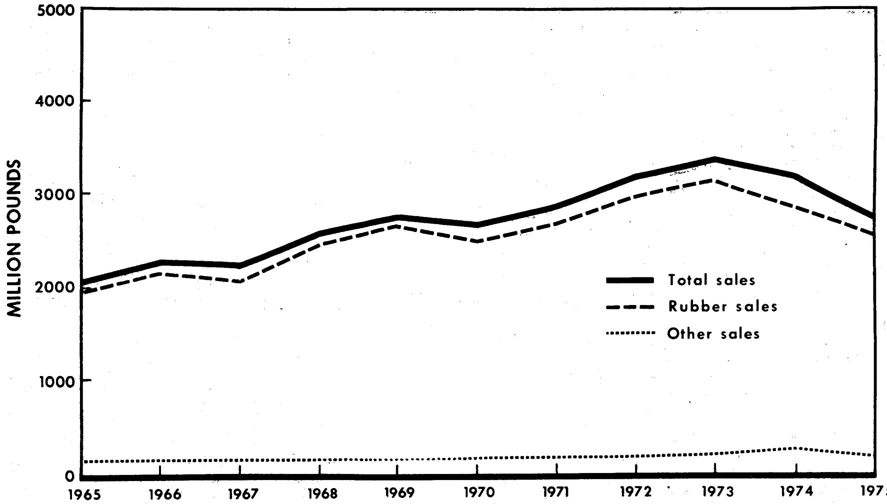

Figure 2.—Sales for domestic consumption.

Table 8.—U.S. exports of carbon black, by country
(Thousand pounds and thousand dollars)

Country	1973 Quantity	1973 Value	1974 Quantity	1974 Value	1975 Quantity	1975 Value
North America:						
Canada	26,226	1,942	15,170	2,259	13,956	1,878
Costa Rica	187	17	4	8	337	62
El Salvador	85	7	47	6	471	10
Guatemala	1,549	161	1,333	159	8	5
Honduras	83	11	100	20	--	--
Jamaica	1,391	148	1,170	141	9	8
Mexico	4,303	342	6,507	446	6,718	977
Other	46	13	72	13	65	15
Total	33,870	2,641	24,403	3,052	21,564	2,955
South America:						
Argentina	1,553	198	1,077	198	379	125
Brazil	24,074	2,178	17,417	2,182	2,028	413
Chile	446	61	340	81	594	100
Colombia	543	79	959	119	188	60
Ecuador	35	8	24	4	61	22
Peru	276	40	263	61	260	55
Uruguay	151	3	66	8	40	13
Venezuela	670	74	651	101	884	187
Other	2	10	33	5	20	6
Total	27,750	2,651	20,830	2,759	4,454	981
Europe:						
Austria	145	17	92	24	--	--
Belgium-Luxembourg	1,900	242	5,014	724	735	155
Denmark	596	125	772	253	56	33
Finland	227	128	117	32	66	20
France	14,444	1,661	23,255	3,733	9,122	1,427
Germany, West	9,380	929	15,444	2,246	5,562	923
Hungary	--	--	81	30	22	8
Italy	4,142	735	5,892	1,503	2,234	530
Netherlands	30,436	5,179	10,174	2,459	873	249
Norway	281	27	265	37	113	16

Table 8.—U.S. exports of carbon black, by country—Continued

(Thousand pounds and thousand dollars)

Country	1973 Quantity	1973 Value	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Europe—Continued						
Poland	9	1	47	7	28	14
Portugal	500	63	172	33	272	45
Romania	522	87	410	168	44	117
Spain	2,741	347	5,188	1,029	2,081	357
Sweden	438	34	480	99	1,046	207
Switzerland	724	93	1,397	198	201	53
United Kingdom	9,411	1,335	10,746	2,239	12,696	1,356
Yugoslavia	328	75	418	r 31	11	3
Other	5	2	47	73	30	44
Total	76,229	11,080	80,011	14,918	35,192	5,557
Africa:						
Algeria	3	4	33	10	16	7
Angola	73	7	329	44	4	1
Egypt	10	2	--	--	23	13
Ethiopia	--	--	--	--	108	21
Ghana	2,262	244	2,337	349	2,750	472
Kenya	1,173	98	1,524	236	1,071	221
Morocco	29	3	42	8	32	6
South Africa, Republic of	5,148	624	8,945	1,049	2,796	456
Tanzania	350	35	1,332	246	905	166
Zambia	44	7	551	84	--	--
Other	50	11	35	5	27	9
Total	9,142	1,035	15,128	2,031	7,732	1,372
Asia:						
Cambodia	110	11	109	19	--	--
Hong Kong	371	58	253	60	252	50
India	619	97	572	135	272	74
Indonesia	252	28	1,242	176	170	33
Iran	55	15	73	16	25	7
Israel	431	59	477	61	375	67
Japan	13,706	3,165	23,452	4,577	4,727	1,962
Korea, Republic of	4,019	486	2,117	256	403	180
Lebanon	136	11	152	21	--	--
Malaysia	155	23	4,872	720	2,920	503
Pakistan	3,123	278	2,365	344	2,234	346
Philippines	1,211	139	1,206	124	144	26
Singapore	277	56	5,188	934	226	38
Sri Lanka	--	--	224	36	304	57
Taiwan	14,110	1,381	6,699	851	5,165	915
Thailand	356	43	3,713	473	658	112
Turkey	164	34	186	40	--	--
Vietnam, South	1,340	160	3,809	517	451	64
Other	16	2	18	4	8	5
Total	40,451	6,046	56,727	9,364	18,334	4,439
Oceania:						
Australia	3,429	411	3,483	672	352	107
New Zealand	1,794	192	1,155	151	319	63
Total	5,223	603	4,638	823	671	170
Grand total	192,665	24,056	201,737	32,947	87,947	15,474

r Revised.

Table 9.—U.S. exports of carbon black in 1975, by month
(Thousand pounds and thousand dollars)

Month	Channel		Furnace		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
January	261	153	4,054	723	4,315	876
February	385	147	4,296	729	4,681	876
March	213	273	5,536	892	5,749	1,165
April	153	195	5,548	827	5,701	1,022
May	193	108	3,281	628	3,474	736
June	212	115	5,242	838	5,454	953
July	217	188	4,914	836	5,131	1,024
August	124	92	7,489	1,353	7,613	1,445
September	532	294	6,946	984	7,478	1,278
October	815	424	8,104	1,344	8,919	1,768
November	551	256	7,562	1,372	8,113	1,628
December	10,023	855	11,296	1,848	21,319	2,703
Total	13,679	3,100	74,268	12,374	87,947	15,474

Table 10.—Carbon black: World production, by country
(Million pounds)

Country [1]	1973	1974	1975 [p]
Argentina [e]	66	66	66
Australia [e]	131	156	160
Belgium [e]	4	4	4
Brazil [e]	143	193	200
Canada [e]	258	249	220
Colombia [e]	50	55	55
Czechoslovakia [e]	66	66	66
France [e]	353	346	325
Germany, West	641	661	[e] 569
Hungary [e]	10	10	10
India	100	143	135
Indonesia [e]	3	6	7
Iran [e]	--	4	15
Italy	324	334	[e] 282
Japan	891	830	815
Korea, Republic of	29	35	53
Mexico [e]	74	75	80
Netherlands	219	223	175
Peru	--	--	[e] 10
Romania	171	173	[e] 176
South Africa, Republic of	88	[e] 83	89
Spain	[r] 129	115	90
Sweden	63	[e] 62	[e] 52
Taiwan [e]	(2)	(2)	(2)
United Kingdom [3]	481	443	[e] 380
United States	3,500	3,390	2,741
Venezuela	18	40	37
Yugoslavia [e]	34	41	[e] 42
Total	[r] 7,846	7,803	6,854

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, the People's Republic of China, Norway, Poland, Turkey, and the U.S.S.R. produce carbon black, but production is not reported, and available information is inadequate to permit formulation of reliable estimates of output levels.
[2] Less than ½ unit.
[3] Includes vegetable black but excludes acetylene and bone black.

Cement

By Jean W. Pressler [1]

Shipments of portland cement including cement imported and distributed by domestic producers from plants in the United States and Puerto Rico in 1975 were 67,776,000 tons, 15% less than in 1974 and the lowest since 1963. This was also 22% below the record shipments of 86.6 million tons in 1973. It was the first time in the past 30 years and only the fourth time in nearly 100 years (1880) that portland cement shipments declined for two or more consecutive years.

In spite of decreased shipments, total mill value was $2.1 billion, compared with that of 1974, reflecting a unit value increase of $4.57 per ton.

In 1975, the cement industry had to contend with soaring fuel costs and the recession. But advantageously, sales and cash flow moved in gear with one another, a basic change since pre-1970. It was easier to put through price increases to offset higher costs, and during 1975 the average price of cement increased 17.2%, in spite of 15% lower shipments. With a projection of the 20-year historical growth rate of 1.4% for portland cement shipments, cement producers will be able to achieve higher operating rates and thus reduce unit costs and increase profit margins. In the next 10 years, undercapacity rather than overcapacity will be a problem because few new plants are scheduled to go onstream in the near future.

Lone Star Industries, Inc.'s Seattle cement plant received the 1975 Clean Air Award from the Washington Lung Association, and its Nazareth, Pa. plant was given the 1975 Environmental Award of the Northampton County Conservation District. Louisville Cement Co.'s Logansport, Ind. plant, with 3,666 days without a lost-time accident, was the leader among Portland Cement Association members competing for the 1975 Safety Contest Awards. An additional 12 plants with more than 1,000 days without a lost-time accident were also mentioned.

According to the National Safety Council, of 41 major industries, the cement industry was in 32d place for average severity of accident rates, but was in first place in the nonmetallic group, with 1,119 days lost from work per million man-hours. For the average injury frequency rate, cement was in 2d place in the surface mining group and 24th place in the 41-major-industry group, with a rate of 10.69 disabling injuries per million man-hours. The average days lost per disabling accident in the cement industry was 105, compared with 57 for all industries combined. The cement industry was divided into two categories: (1) Mills, which had an average accident frequency rate of 10.63 and a severity rate of 975; and (2) quarries, which had 11.13 and 2,357, respectively.

Continuing from yearend 1974, the construction industry, and residential building especially, was severely hit in the 1975 recession by the high cost of money and inflation; this resulted in high unemployment in the industry, and shipments declined in 1975 for the second year in a row. In the last half of the year, the economy started to recover, the construction industry began to follow along, and shipments of cement increased slightly, thus setting the stage for increased production.

Many cement producers were converting their plants to the use of coal, or to its utilization as a backup fuel, principally owing to rising energy costs and natural

[1] Physical scientist, Division of Nonmetallic Minerals.

gas shortages. Increased utilization of preheaters, conversion from wet to dry processing, and exploration, development, and investment activities to establish independent fuel reserves were becoming accepted energy conservation measures.

Statistical data in some tables are arranged by State or groups of States to form cement districts. A cement district represents either a segment of a State or a group of contiguous States. In several cases it was necessary to group together States that are not contiguous. The States of California, New York, and Pennsylvania were divided to provide additional marketing information. Divisions for these States are as follows:

California, Northern.—Points north and west of the northern borders of San Luis Obispo and Kern Counties and the western borders of Inyo and Mono Counties.

California, Southern.—All other counties in California.

New York, Western.—All counties west of a dividing line following the eastern boundaries of St. Lawrence, Lewis, Oneida, Madison, Chenango, and Broome Counties.

New York, Eastern.—All counties east of the above dividing line.

New York, Metropolitan.—The five counties of New York City (Bronx, Kings, New York, Queens, and Richmond) plus Westchester, Rockland, Suffolk, and Nassau Counties.

Pennsylvania, Eastern.—All counties east of the eastern boundaries of Potter, Clinton, Centre, Huntingdon, and Franklin Counties.

Pennsylvania, Western.—All other counties in Pennsylvania.

Table 1.—Salient cement statistics

(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:[1]					
Production[2]	78,324	82,597	85,513	80,917	68,139
Shipments from mills[2 3]	80,396	83,336	88,665	81,033	69,102
Value[2 3 4]	$1,528,056	$1,724,140	$1,975,409	$2,150,659	$2,159,160
Average value per ton[2 3 4]	$19.01	$20.69	$22.28	$26.54	$31.25
Stocks Dec. 31 at mills[2]	6,425	7,036	5,512	7,467	6,930
Exports	84	83	268	199	417
Imports for consumption	3,057	4,851	6,647	5,702	3,637
Consumption, apparent[5 6]	81,498	84,952	90,679	82,862	70,062
World: Production	679,948	723,796	r 773,769	r 776,066	766,347

r Revised.
[1] Excludes Puerto Rico.
[2] Portland and masonry cement only.
[3] Includes imported cement shipped by domestic producers.
[4] Value received, f.o.b. mill, excluding cost of containers.
[5] Quantity shipped plus imports minus exports.
[6] Adjusted to eliminate duplication of imported clinker and cement shipped by domestic cement manufacturers.

DOMESTIC PRODUCTION

During 1975, 1 State agency and 56 companies operated 178 plants in 41 States, and another 2 companies operated 3 plants in Puerto Rico to manufacture 1 or more kinds of hydraulic cement.

PORTLAND CEMENT

Manufacturers in the United States and Puerto Rico produced 64,539,000 tons of clinker and imported 1,207,000 tons of foreign clinker to grind 66,796,000 tons of portland cement. Domestic producers shipped 67,776,000 tons of portland cement, which included 980,000 tons of imported cement. Stocks at mills decreased by 0.5 million tons. An additional 1.3 million tons of portland cement was imported and shipped or used by others not producing cement in the United States and Puerto Rico.

Much capacity was shut down during the year, mostly obsolete or inefficient equipment, especially kilns and mills, that was not replaced. Several major expansion and improvement programs involving new kilns and mills were completed during the year.

The rate of installation of dust collectors in the cement industry remained high during 1975, but was not quite up to 1974, or the record pace of 1973, when dust collectors were the biggest single item installed.

Only three new cement distribution terminals were known to have been built in 1975, but several were enlarged. None is known to have been closed down. At two of the five cement plants shut down completely during the year, the storage and distribution facilities will be used as terminals for other company plants.

Thirty-one companies had multiplant operations ranging in number from 2 to 14 plants. Nevertheless, no single company accounted for more than 6.4% of the total clinker production capacity. The 5 largest producers comprised 25.8% of the clinker production capacity; the 10 largest accounted for 46.5%; and the 20 largest had 72.2% of the total capacity. The 10 largest companies in terms of clinker production capacity were: Ideal Basic Industries, Inc; General Portland, Inc.; National Gypsum Co.; Martin Marietta Cement; Amcord, Inc.; Universal Atlas Div. of United States Steel Corp.; Kaiser Cement & Gypsum Corp.; Marquette Cement Manufacturing Co.; Medusa Cement Co.; and Lone Star Industries, Inc. (including Citadel Cement Corp., a joint venture). The largest individual plant was at Alpena, Mich., operated by Huron Cement Div. of National Gypsum Co.

Production Capacity.—Only one new single-kiln plant with an annual capacity of 550,000 tons was brought into production during the year. An additional 9 new kilns started operating at existing plants, while 41 old kilns were permanently removed from service, leaving a net annual capacity loss of about 2,700 tons per day. Of the 10 new kilns installed, 2 were wet process, 2 were dry process, and 6 were dry process with suspension preheaters.

At yearend 435 kilns were being operated by 52 companies and a State-owned company in South Dakota at 164 plants in 41 States and Puerto Rico, with an estimated 24-hour daily clinker production capacity of 290,000 tons. An average of 47 days of downtime was reported for kiln maintenance and replacing refractory brick. Based on 318 days of operation, the apparent annual clinker production capacity of the industry was 92.3 million tons.

In 1975, the closing of 5 plants and the startup of 1 new plant, coupled with the annual reappraisal of daily clinker production capacity by 25 companies, resulted in a net loss of 2,700 tons of daily clinker capacity. A recapitulation of this net loss follows:

Type of change	Number of kilns	Tons per day
New, added, replacement	+10	+14,014
Abandoned	−41	−11,814
Company reappraisal	--	− 4,906
Net change	−31	− 2,706

At yearend the average annual clinker capacity of each plant in the United States was 570,000 tons, and the average annual clinker capacity of each kiln was 209,000 tons. Average kiln capacity varies widely with the many States and market areas, from 95,000 tons per year in one State to 430,000 tons per year in another. Seven States representing 17% of total U.S. capacity have an average kiln capacity of 350,000 tons per year, and 22 States representing 60% of total U.S. capacity have an average kiln capacity of 270,000 tons per year.

The 20-year historical growth rate of U.S. cement capacity, including Puerto Rico and clinker imports, is 1.4%. Although clinker manufacturing capacity has been increasing at a rate similar to that of domestic cement consumption, clinker imports have been increasing at a much faster rate and may in time support a more rapid U.S. clinker capacity growth rate. It is estimated that through 1985 the clinker-manufacturing-capacity growth rate may approach 2.5%.

During the year 168 clinker-producing plants, including 7 white cement facilities, were in operation. Six of the white cement facilities were adjacent to gray cement plants. Twelve grinding mills operated only on imported, purchased, or interplant transfers of clinker: Four of these produced only masonry cement, one ground both portland and masonry cement, and seven ground portland cement only. Based on the fineness necessary to grind Types I and II cements, and making allowances for downtime required for maintenance, the cement industry in the United States and Puerto Rico had an estimated grinding capacity of 106 million tons of cement annually.

During 1975 clinker was produced by wet-process kilns at 98 plants and by dry-process kilns at 64 plants; 6 plants had both processes in operation. Dry-process kilns with preheaters were becoming increasingly important because of lower fuel consumption.

In the interests of energy conservation and the realization of substantial fuel economies, 23 companies in 28 different plants were utilizing 48 preheater installations in their kiln operations at yearend. Seven Grudex[2] preheaters were operating on 10 kilns at 2 plants, and 7 traveling-grate preheaters were operating at 4 different plants. A steady growth in installation of suspension preheaters continued in 1975. During the year, nine new suspension preheaters were put onstream and ranged in size from 550 to 2,000 tons per day. From 1973 through 1975, the number of suspension preheaters almost doubled. There were 18 suspension preheaters in 1973, 25 in 1974, and 34 in 1975.

New Plant Installations.—Only one new plant was completed in 1975. Late in December the Florida Mining and Materials Corp. started up its new $31 million, 550,000-ton-per-year cement plant near Brooksville, Fla. This was the only all-new cement plant at a new location completed during the year. All mechanical and electrical equipment was supplied by the Polysius Corp. of Atlanta, Ga., including a pneumatic homogenizing system, a 24-foot, four-stage counterflow GEPOL suspension preheater with a 14.5-foot by 229-foot-long dry-process kiln, a 20-foot-diameter separator, a 13- by 32-foot airswept raw ball mill, and an air-lift conveyor system. Other equipment included a Jeffrey 600-horsepower reversible limestone crusher, a Hazemag 45-ton-per-hour crusher, a 280-ton-per-hour Pohlig-Heckel-Bleichert Vereinigte Maschinenfabriken AG (PHB) reclaiming scraper, a Fuller grate cooler, two 2,500-horsepower finish mills, and a Joy (Western Precipitation) glass baghouse.

Plant Closures.—Five plants permanently ceased production of cement and clinker in 1975: Ideal Basic Industries, Inc. (Baton Rouge, La.); Marquette Cement Manufacturing Co. (Milwaukee, Wis.); Universal Atlas Cement Div., United States Steel Corp. (Fairborn, Ohio and Duluth, Minn.); and The National Portland Cement Co. (Brodhead, Pa.).

Plant Improvements and Expansions.—During 1975, three plants replaced or supplemented existing plants at the same location. They are Ash Grove Portland Cement Co., Louisville. Nebr.; Citadel Cement Corp., Roanoke, Va.; and Missouri Portland Cement Co., Joppa, Ill.[3]

Seven major expansion and improvement programs involving new kilns or kilns and mills were completed in 1975. They were Kaiser Cement & Gypsum Corp., Longhorn Div., San Antonio, Tex.; Martin Marietta Corp., Southern Div., Roberta, Ala.; Maule Industries, Inc., Pennsuco, Fla; Missouri Portland Cement Co., Joppa, Ill.; The Monarch Cement Co., Humboldt, Kans.; National Gypsum Co., Huron Cement Div., Alpena, Mich.; Northwestern States Portland Cement Co., Fort Dodge, Iowa; and The Whitehall Cement Manufacturing Co., Cementon, Pa.

The Ash Grove Portland Cement Co. in 1975 completed the second phase of a three-phase program at Louisville, Nebr. Phase II included a new dry-process kiln with a traveling-grate preheater and a cooler. This kiln replaced five old wet-process kilns. Also included were four 2,170-ton kiln feed silos, a coal mill, a double-chamber precipitator for the kiln, and a baghouse collector for the cooler.

Citadel Cement Corp., a joint venture of Lone Star Industries, Inc., and Canada Cement Lafarge Ltd., completed the $35 million expansion of its plant near Roanoke, Va. New equipment included a grate preheater kiln, a 22-foot-diameter pelletizing pan, three electrostatic precipitators, a 10- by 41-foot clinker cooler, two raw roller mills, two 13- by 34-½-foot finish mills, a homogenizing system, and a computer system. Site preparation started for Citadel's new 750,000-ton-per-year $50 million cement plant at Demopolis, Ala., which is now scheduled for startup in mid-1976. This plant will replace the existing plant at the site being operated by Citadel under lease from Lone Star Industries.

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[2] Grudex is a special type of preheater developed by Coplay Cement Manufacturing Co. and fabricated by Kennedy Van Saun Corp.

[3] Trauffer, W. E. Outlook & Review 1975–1976: Portland Cement—Costs, Prices Up, Revenue Static in 1975; Increased Shipments Expected in 1976. Pit & Quarry, v. 68, No. 7, January 1976, pp. 55–65.

Kaiser Cement & Gypsum Corp. completed an expansion program at its Longhorn Div. plant near San Antonio, Tex. The capacity of this plant was nearly doubled. New equipment included a dry-process kiln with a suspension preheater and grate cooler, a raw roller mill, and a modular glass baghouse for both the kiln and cooler. More than $1 million went into air pollution control equipment. The kiln and mill are controlled by electronic instrumentation. Early in 1975 Kaiser announced the completion of a new cement distribution terminal in Phoenix to serve the Arizona market. A 1,600-ton silo was added to the terminal on Kauai, Hawaii.

A major expansion and renovation program at the Roberta, Ala., plant of Martin Marietta Corp. included kiln and cooler baghouses, expanded feed ends and chain systems in the two cement kilns, the installation of a raw mill and related facilities, and the conversion of raw mills to finish grinding.

Maule Industries, Inc., completed the first of two stages of an expansion program at its Pennsuco, Fla., plant. This increased its capacity from 430,000 tons per year to about 1,200,000 tons per year.

Missouri Portland Cement Co. completed a $21 million expansion of its Joppa, Ill., cement plant, which doubled its capacity to 750,000 tons per year.

The Monarch Cement Co. completed a $13 million expansion, modernization, and pollution control program begun in 1971 at its Humboldt, Kans., plant. This is one of the few plants in the United States with 100% of its production from preheater kilns.

At the Alpena, Mich., plant of the Huron Cement Div., National Gypsum Co., a major modernization and expansion program was completed. A unique feature was the use of two waste-heat boilers, which transform waste heat from the kiln into power through the use of steam generators.

Northwestern States Portland Cement Co. completed a major expansion and improvement program at its Mason City, Iowa, plant.

The Whitehall Cement Manufacturing Co. completed the expansion of its plant at Cementon, Pa. Operation of the kiln and mill is controlled by the existing on-line process control computer.

The swing to coal firing of kilns was evident from the fact that 20 Raymond coal mills were shipped to U.S. plants in 1975, and 26 were scheduled for 1976 installation.

New plant and important plant expansion and improvement programs reported in 1975 involved a total expenditure of at least $313 million, well ahead of similar estimates in any recent year.

Alpha Portland Cement Co. reportedly completed another phase of a 4-year modernization and expansion program at its Birmingham, Ala., plant, which included a new quarry.

Amcord, Inc., completed the conversion from natural gas to coal firing at the three plants of its western subsidiaries—Phoenix Div. at Clarkdale, Ariz., and the two Riverside Div. plants at Oro Grande and Riverside, Calif.

Coplay Cement Manufacturing Co. was reported to have purchased the cement plant at Craigsville, Va., which was shut down in 1968 by Lehigh Portland Cement Co. This plant was to be rehabilitated and used to process clinker from Coplay's Pennsylvania plants.

Cyprus Hawaiian Cement Corp., owned by Cyprus Mines Corp., completed the final stage of an expansion program which increased capacity to 470,000 tons per year.

The Dundee, Mich., plant of Dundee Cement Co. commissioned two gravel-bed filter systems to clean the clinker coolers' exhaust air of particulates. The filter systems were controlled by programmable controllers.

At the San Andreas, Calif., plant of the Calaveras Cement Div. of The Flintkote Co., a $4 million improvement program was completed. Engineering was underway for coal-burning systems to be installed at both the Division's plants. At the Diamond-Kosmos Div. plant at Middlebranch, Ohio, three kilns were shut down, and the fourth operated under an Environmental Protection Agency variance that was to expire July 1, 1976.

Ideal Cement Co. reportedly has well underway the modernization program at the Knoxville, Tenn., plant of its Volunteer Div. Production of cement at Ideal's Baton Rouge, La., plant was terminated permanently on March 31, 1975, but the site will continue as a distribution terminal. Originally built as an aluminum-sintering plant during World War II, it was purchased by Ideal in 1950 and converted to portland cement manufacture in 1951. Ideal was planning conversion of all plants using either natural gas or oil, to coal as the primary fuel. Stansbury Coal Co., a joint venture of Ideal, will reopen a mine near Rock Springs, Wyo., to produce coal for the company's plants at Boettcher, Colo., Superior, Nebr., Devil's Slide, Utah, Trident, Mont., and Seattle, Wash.

At the Bath, Pa., plant of Keystone Portland Cement Co., two baghouse collectors were installed on clinker coolers. Conversion to the use of coal as a primary fuel was also accomplished.

Louisville Cement Co. announced that it was awarding a contract to design and build a suspension preheater kiln and raw roller mill system at its Speed, Ind., plant at a cost of about $25 million.

The Marquette Co. is reported to have well underway at its Hagerstown, Md., plant a $7 million improvement program. Marquette permanently closed down its 230,000-ton-per-year cement plant in Milwaukee, Wis. This will be used only as a distribution center.

At the Martinsburg, W. Va., plant of Martin Marietta Corp. the installation of three clinker cooler baghouses was completed. Installation of a clinker cooler baghouse was completed at the Thomaston, Maine plant and engineering was in progress to convert this plant from wet to semidry. At the Davenport, Iowa, plant a major improvement and renovation program at a cost of some $10 million was completed. Construction was nearing completion on coal handling, storage, and grinding facilities at the Tulsa, Okla., plant.

National Cement Co., Inc., which was acquired by the Société des Ciments Vicat of Grenoble, France, from the Mead Corp. in mid-1974 was reportedly making good progress on the modernization and expansion program then announced for its Ragland, Ala., plant. An SF process clinker flash-calcining system, the first in this country, with a four-stage suspension preheater, was ordered.

Allentown Portland Cement Co., a division of National Gypsum Co., reportedly completed the expansion of its Evansville, Pa., plant.

The Oregon Portland Cement Co. was installing an electrostatic precipitator at its Lime, Oreg., plant.

The Cement Div. of Penn-Dixie Industries, Inc., was installing two electrostatic precipitators at its plants at Kingsport and Richard City, Tenn., both for completion in 1976.

Puerto Rican Cement Co., Inc., with plants at Ponce and San Juan, P.R., late in 1974 was granted a price increase and a Puerto Rican Government loan of about $15 million to help finance an air pollution control program now underway at these plants.

San Juan Cement Co., Inc., put into operation a $5 million emission control program which included increasing the capacity of existing baghouses and installing bag dust collectors throughout the plant.

The South Dakota Cement Plant, Rapid City, S. Dak., was conducting a major expansion program.

The Universal Atlas Cement Div. of United States Steel Corp. was installing a new 600,000-ton-per-year dry-process cement operation at Leeds, Ala. Extensive modernization and expansion at its Buffington, Ind., plant was completed in mid-1975. Universal Atlas announced that it would close down permanently, at the end of 1975, its plants at Fairborn, Ohio, and Duluth, Minn.

Table 2.—Portland cement shipped by producers in the United States, by district [1] [2]

(Thousand short tons and thousand dollars)

District	1974			1975		
	Quantity	Value	Average per ton	Quantity	Value	Average per ton
New York and Maine	4,733	121,779	$25.73	3,697	97,102	$26.27
Eastern Pennsylvania	5,297	141,321	26.68	4,076	118,453	29.06
Western Pennsylvania	2,150	50,273	23.38	1,738	49,766	28.63
Maryland and West Virginia	2,363	59,116	25.02	1,817	53,866	29.65
Ohio	2,884	73,815	25.59	2,364	70,268	29.72
Michigan	5,903	140,513	23.80	4,573	131,324	28.72
Indiana, Kentucky, Wisconsin	3,189	78,735	24.69	3,039	88,537	29.13
Illinois	1,460	41,023	28.10	1,374	42,756	31.12
Tennessee	1,525	43,339	28.42	1,136	37,866	33.33
Virginia, North Carolina, South Carolina	2,788	78,599	28.19	2,382	76,789	32.24
Georgia	1,150	31,535	27.42	828	25,822	31.19
Florida	2,562	75,133	29.33	1,721	62,525	36.33
Alabama	2,190	61,990	28.31	1,968	62,599	31.81
Louisiana and Mississippi	1,701	49,483	29.09	1,388	44,723	32.22
Minnesota, South Dakota, Nebraska	1,583	43,133	27.25	1,527	49,235	32.24
Iowa	2,424	64,156	26.47	2,258	73,786	32.68
Missouri	4,229	106,985	25.30	3,962	116,260	29.34
Kansas	1,940	46,940	24.20	1,832	55,033	30.04
Oklahoma and Arkansas	2,595	67,723	26.10	2,240	67,517	30.14
Texas	7,739	207,706	26.84	7,195	224,804	31.24
Wyoming, Montana, Idaho	1,080	28,124	26.04	964	30,273	31.40
Colorado, Arizona, Utah, New Mexico	3,458	94,761	27.40	3,322	111,496	33.56
Washington	1,377	36,347	26.40	1,147	40,666	35.45
Oregon and Nevada	912	23,283	25.53	883	31,666	35.86
Northern California	2,907	73,704	25.35	2,362	77,073	32.63
Southern California	5,355	136,774	25.54	4,964	155,477	31.32
Hawaii	487	16,405	33.69	456	19,942	43.73
Puerto Rico	1,881	70,277	37.36	1,582	60,968	38.54
U.S. total or average [3] [4]	77,865	2,062,972	26.49	66,796	2,076,594	31.09
Foreign imports [5]	1,617	44,934	27.79	980	30,426	31.05
Total or average	79,482	2,107,906	26.52	67,776	2,107,020	31.09

[1] Includes data for eight white cement facilities—Texas (three), Pennsylvania (two), and one each in California, Florida, and Wisconsin—and for grinding plants (eight in 1974; seven in 1975) as follows: Two each in Michigan and Wisconsin, Pennsylvania (two in 1974 and one in 1975), and one each in Florida and Virginia. Data for the Superior, Wis., plant are included with Michigan (1974). G. & W. H. Corson, Inc. (Pennsylvania) discontinued grinding operations in 1974. The National Portland Cement Co. (Pennsylvania) did not operate in 1975.
[2] Includes Puerto Rico.
[3] Data may not add to total shown because of independent rounding.
[4] Includes cement produced from imported clinker.
[5] Cement imported and distributed by domestic producers only.

Table 3.—Portland cement production, capacity, and stocks in the United States, by district [1] [2]

(Thousand short tons)

District	1974					1975				
	Plants active during year	Production [3]	Capacity [4]		Stocks [5] at mills Dec. 31	Plants active during year	Production [3]	Capacity [4]		Stocks [5] at mills Dec. 31
			Finish grinding	Percent utilized				Finish grinding	Percent utilized	
New York and Maine	10	4,924	6,560	75.1	546	10	3,647	6,550	55.6	515
Eastern Pennsylvania	14	5,630	7,119	79.1	641	12	4,029	6,924	58.1	446
Western Pennsylvania	5	2,312	2,899	79.8	281	5	1,852	2,885	64.1	271
Maryland and West Virginia	4	2,395	2,962	80.9	194	4	1,849	2,842	65.0	199
Ohio	8	2,918	3,540	82.4	273	8	2,292	3,572	64.1	197
Michigan	8	5,844	8,332	70.1	685	8	4,634	7,543	61.4	691
Indiana, Kentucky, Wisconsin	r 10	3,528	4,569	77.2	341	10	3,032	4,926	61.5	356
Illinois	4	1,592	2,096	76.0	176	4	1,481	2,096	70.6	155
Tennessee	6	1,557	2,208	70.5	116	6	1,198	2,286	52.4	112
Virginia, North Carolina, South Carolina	6	2,920	4,792	60.9	213	6	2,396	4,804	49.8	237
Georgia	3	1,167	1,482	78.7	86	3	843	1,477	57.0	69
Florida	5	2,362	3,716	63.6	323	5	1,676	4,119	40.6	210
Alabama	7	2,322	2,947	78.8	205	7	1,995	2,781	71.7	214
Louisiana and Mississippi	6	1,699	2,648	64.2	162	6	1,330	2,648	50.2	123
Minnesota, South Dakota, Nebraska	4	1,594	2,233	71.4	164	4	1,479	2,197	67.3	139
Iowa	5	2,449	2,861	85.6	180	5	2,208	2,824	78.1	196
Missouri	7	4,298	5,150	83.4	396	7	3,919	5,150	76.1	387
Kansas	5	1,996	2,169	92.0	219	5	1,835	2,341	78.3	222
Oklahoma and Arkansas	5	2,695	3,442	78.3	247	5	2,232	3,452	64.6	253
Texas	18	7,889	9,961	79.2	644	18	7,074	9,940	71.1	471
Wyoming, Montana, Idaho	4	1,092	1,218	89.6	106	4	1,005	1,209	83.1	115
Colorado, Arizona, Utah, New Mexico	8	3,351	5,380	62.3	234	8	3,295	5,685	57.9	260
Washington	4	1,389	2,260	61.5	93	4	1,379	2,118	65.0	131
Oregon and Nevada	3	916	1,385	66.1	45	3	858	1,385	61.9	36
Northern California	4	2,723	3,229	84.3	234	4	2,214	3,229	68.5	218
Southern California	8	5,479	7,907	69.3	281	8	4,997	7,810	63.9	271
Hawaii	2	474	500	94.8	28	2	466	550	84.7	38
Puerto Rico	3	1,971	2,658	74.2	43	3	1,582	2,768	57.1	43
Total	r 176	79,486	106,223	74.8	7,156	174	[6] 66,796	106,111	62.9	6,575

r Revised.
[1] Includes Puerto Rico.
[2] Includes data for eight white cement facilities—Texas (three), Pennsylvania (two), and one each in California, Florida, and Wisconsin—and for grinding plants (eight in 1974, seven in 1975) as follows: Two each in Michigan and Wisconsin, Pennsylvania two in 1974 and one in 1975, and one each in Florida and Virginia. Data for the Superior, Wis., plant are included with Michigan (1974). G. & W. H. Corson, Inc. (Pennsylvania) discontinued grinding operations in 1974. The National Portland Cement Co. (Pennsylvania) did not operate in 1975.
[3] Includes cement produced from imported clinker (1974—1,904; 1975—1,240).
[4] Grinding capacity based on fineness necessary to grind Types I and II cement, making allowance for downtime required for maintenance.
[5] Includes imported cement. Source of imports withheld to avoid disclosing individual company confidential data.
[6] Data do not add to total shown because of independent rounding.

Table 4.—Clinker capacity and production in the United States, by district, as of December 31, 1975 [1] [2]

District	Active plants: Process used: Wet	Dry	Both	Total	Number of kilns	Daily capacity (thousand short tons)	Average number of days for maintenance	Apparent annual capacity [3] (thousand short tons)	Production [4] (thousand short tons)	Percent utilized
New York and Maine	6	4	--	10	19	18.9	31	6,305	3,554	56.3
Eastern Pennsylvania	3	8	--	11	50	19.4	35	6,395	3,933	61.5
Western Pennsylvania	3	2	--	5	13	8.1	44	2,598	1,761	67.7
Maryland and West Virginia	2	2	--	4	10	8.1	56	2,500	1,836	73.4
Ohio	3	3	1	7	12	9.0	50	2,833	2,231	78.7
Michigan	5	1	--	6	29	21.1	56	6,530	4,654	71.2
Indiana, Kentucky, Wisconsin	3	4	--	7	14	11.6	41	3,754	2,644	70.4
Illinois	--	4	--	4	8	8.3	48	2,634	1,554	58.9
Tennessee	6	--	--	6	13	5.7	58	1,752	1,270	72.4
Virginia, North Carolina, South Carolina	3	2	--	5	13	11.0	73	3,207	2,324	72.4
Georgia	--	2	1	3	5	5.1	32	1,698	815	47.9
Florida	4	1	--	5	11	11.1	36	3,650	1,518	41.5
Alabama	4	3	--	7	18	7.9	40	2,570	1,994	77.5
Louisiana and Mississippi	5	--	--	5	10	6.5	54	2,020	1,328	65.7
Minnesota, South Dakota, Nebraska	2	--	1	3	9	4.6	52	1,442	1,507	104.5
Iowa	3	2	--	5	17	8.1	53	2,526	2,183	86.4
Missouri	5	2	--	7	12	15.4	50	4,847	3,685	76.0
Kansas	3	2	--	5	15	7.0	44	2,249	1,786	79.4
Oklahoma and Arkansas	3	2	--	5	11	8.5	43	2,737	2,168	79.2
Texas	13	3	2	18	48	27.8	48	8,821	6,842	77.5
Wyoming, Montana, Idaho	4	--	--	4	5	3.1	25	1,055	1,046	99.1
Colorado, Arizona, Utah, New Mexico	3	5	--	8	21	13.6	43	4,379	3,228	73.7
Washington	3	1	--	4	7	3.7	31	1,235	1,086	87.9
Oregon and Nevada	2	1	--	3	7	3.3	52	1,033	850	82.2
Northern California	2	2	--	4	13	9.2	44	2,957	2,203	74.5
Southern California	2	5	1	8	29	22.3	44	7,169	4,630	64.5
Hawaii	1	1	--	2	3	2.3	51	722	443	61.3
Puerto Rico	3	--	--	3	13	9.3	80	2,646	1,466	55.4
Total or average	96	62	6	164	435	290.0	47	92,264	64,539	70.0

[1] Includes Puerto Rico.
[2] Includes white cement producing facilities and the new Florida Mining and Materials Corp. (Brookville, Fla.) plant. Excludes five plants that permanently ceased clinker operations during 1975. Plants not active Dec. 31, 1975 were Ideal Basic Industries, Inc. (Baton Rouge, La.), Marquette Cement Manufacturing Co. (Milwaukee, Wis.), Universal Atlas Cement Div., United States Steel Corp. (Fairborn, Ohio, and Duluth, Minn.), and The National Portland Cement Co. (Brodhead, Pa.).
[3] Calculated on individual company data: 365 days, minus average days for maintenance, times the reported 24-hour capacity.
[4] Includes production reported for plants which added or shut down kilns during the year.

Table 5.—Daily clinker capacity, December 31 [1 2]

Short tons per 24-hour period	Number: Plants	Number: Kilns [3]	Total capacity (short tons)	Percent of total capacity
1974:				
Less than 600	4	7	2,337	0.8
600 to 1,150	45	87	39,723	13.6
1,150 to 1,700	51	130	70,711	24.2
1,700 to 2,300	35	103	68,166	23.3
2,300 to 2,800	12	38	30,624	10.4
2,800 and over	21	101	81,147	27.7
Total	168	466	292,708	100.0
1975:				
Less than 600	5	8	2,891	1.0
600 to 1,150	42	83	39,036	13.4
1,150 to 1,700	49	113	66,055	22.8
1,700 to 2,300	33	97	64,336	22.2
2,300 to 2,800	15	46	37,616	13.0
2,800 and over	20	88	80,124	27.6
Total	164	435	290,058	100.0

[1] Includes Puerto Rico.
[2] Includes white-cement-producing facilities and the new Florida Mining and Materials Corp. (Brookville, Fla.) plant. Excludes five plants that permanently ceased clinker operations during 1975. Plants not active Dec. 31, 1975 were Ideal Basic Industries, Inc. (Baton Rouge, La.), Marquette Cement Manufacturing Co. (Milwaukee, Wis.), Universal Atlas Cement Div., United States Steel Corp. (Fairborn, Ohio and Duluth, Minn.), and The National Portland Cement Co. (Brodhead, Pa.).
[3] Total number in operation at plants.

Table 6.—Raw materials used in producing portland cement in the United States [1]
(Thousand short tons)

Raw materials	1974	1975
Calcareous:		
Limestone (includes aragonite)	87,667	76,414
Cement rock (includes marl)	23,417	17,869
Oystershell	4,922	3,006
Argillaceous:		
Clay	7,771	6,659
Shale	3,984	3,447
Other (includes staurolite, bauxite, aluminum dross, pumice, and volcanic material)	280	208
Siliceous:		
Sand	2,235	1,813
Sandstone and quartz	846	582
Ferrous: Iron ore, pyrites, millscale, and other iron-bearing material	800	772
Other:		
Gypsum and anhydrite	4,172	3,527
Blast furnace slag	805	465
Fly ash	322	180
Other, n.e.c	6	2
Total	137,227	114,944

[1] Includes Puerto Rico.

MASONRY CEMENT

Shipments of masonry cement including foreign imports were 2.9 million tons, 15% below the 1974 level and down 29% from the record 4.1 million tons shipped in 1973. The unit value increased $5.97 per ton to $38.90, and the total value of shipments was $113 million. By yearend 115 plants were manufacturing masonry cement. Five plants produced masonry cement exclusively: Cheney Lime & Cement Co., Allgood, Ala.; Martin Marietta Cement. North Birmingham, Ala.; M. J. Grove Lime Div. of The Flintkote Co., Frederick, Md.; G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; and Riverton Corp., Riverton, Va. In some States, masonry cement was not produced because the majority of the masons preferred to purchase portland cement and add clay or lime for plasticity on the job.

Table 7.—Masonry cement shipped by producers in the United States, by district [1] [2]

(Thousand short tons and thousand dollars)

District	1974			1975		
	Quantity	Value	Average per ton	Quantity	Value	Average per ton
New York and Maine	110	3,464	$31.49	90	2,721	$30.23
Eastern Pennsylvania	258	9,602	37.22	221	9,562	43.27
Western Pennsylvania	145	5,039	34.75	136	5,078	37.34
Maryland and West Virginia	128	3,878	30.30	101	3,301	32.68
Ohio	158	5,227	33.08	136	4,576	33.65
Michigan	217	6,309	29.07	183	6,429	35.13
Indiana, Kentucky, Wisconsin	470	14,745	31.37	415	14,980	36.10
Illinois	69	3,228	46.78	69	3,658	53.01
Tennessee	154	4,706	30.56	138	4,778	34.62
Virginia, North Carolina, South Carolina	332	12,937	38.97	281	12,781	45.48
Georgia	40	1,304	32.60	23	826	35.91
Florida	235	4,737	20.16	147	6,897	46.92
Alabama	314	11,322	36.06	262	10,253	39.13
Louisiana and Mississippi	45	1,433	31.84	43	1,441	33.51
Minnesota, South Dakota, Nebraska	33	1,052	31.88	33	1,385	41.97
Iowa	65	2,660	40.92	62	2,933	47.31
Missouri	75	2,434	32.45	65	2,110	32.46
Kansas	64	2,203	34.42	57	2,311	40.54
Oklahoma and Arkansas	115	3,549	30.86	108	3,912	36.22
Texas	195	6,438	33.02	181	7,089	39.17
Wyoming, Montana, Idaho	7	239	34.14	7	273	39.00
Colorado, Arizona, Utah, New Mexico	119	3,636	30.55	89	3,459	38.87
Washington	6	193	32.17	5	209	41.80
Oregon and Nevada, Northern California, Southern California	2	64	32.00	2	74	37.00
Hawaii	14	706	50.43	13	762	58.62
Puerto Rico	--	--	--	--	--	--
U.S. total or average [3]	3,370	111,107	32.97	2,868	111,800	38.99
Foreign imports [4]	62	1,923	31.02	40	1,308	32.70
Total or average	3,432	113,030	32.93	2,908	113,108	38.90

[1] Does not include quantities produced on the job by masons.
[2] Includes Puerto Rico.
[3] Data may not add to totals shown because of independent rounding.
[4] Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing individual company confidential data.

Table 8.—Masonry cement production and stocks in the United States, by district[1]

(Thousand short tons)

District	1974 Plants active during year	1974 Production	1974 Stock[2] at mills December 31	1975 Plants active during year	1975 Production	1975 Stock[2] at mills December 31
New York and Maine	6	116	13	6	90	12
Eastern Pennsylvania	10	269	33	10	219	27
Western Pennsylvania	5	145	16	5	138	18
Maryland and West Virginia	3	132	6	3	101	4
Ohio	5	160	11	5	137	12
Michigan	4	200	51	5	220	79
Indiana, Kentucky, Wisconsin	5	463	32	5	416	37
Illinois	2	77	13	2	67	11
Tennessee	5	175	13	5	154	15
Virginia, North Carolina, South Carolina	5	336	18	5	282	19
Georgia, Florida	5	257	31	4	147	22
Alabama	7	323	26	7	266	31
Louisiana and Mississippi	2	38	3	3	36	3
Minnesota, South Dakota, Nebraska	4	31	8	4	38	12
Iowa	3	69	9	3	69	15
Missouri	4	80	12	4	66	13
Kansas	5	58	13	5	66	22
Oklahoma and Arkansas	5	110	4	5	107	6
Texas	12	216	24	12	189	21
Wyoming, Montana, Idaho	4	7	3	4	8	4
Colorado, Arizona, Utah, New Mexico	6	120	10	6	90	11
Washington	4	4	2	4	6	2
Oregon and Nevada	--	--	(3)	--	--	(3)
Northern California	--	--	(3)	--	--	(3)
Southern California	1	3	1	1	(3)	(3)
Hawaii	2	14	2	2	13	2
Puerto Rico	--	--	--	--	--	--
Total	114	[4,5] 3,402	354	115	[4] 2,925	398

[1] Includes Puerto Rico.
[2] Includes imported cement.
[3] Less than 500 short tons.
[4] Includes 2,558 tons produced from clinker, 844 tons produced from cement (1974); 2,185 tons produced from clinker, 739 tons produced from cement (1975).
[5] Data do not add to total shown because of independent rounding.

ALUMINOUS CEMENT

Aluminous cement, also known as calcium aluminate cement, high-alumina cement, and "Ciment Fondu," is a nonportland hydraulic cement produced at three plants in the United States. Universal Atlas Cement Div., United States Steel Corp., manufactured calcium aluminate clinker and cement at a facility adjacent to its gray portland cement plant in Buffington, Ind. The Aluminum Co. of America operated kilns and grinding facilities to produce aluminous cement at Bauxite, Ark. Lone Star Lafarge Co. (a joint venture between Lone Star Industries, Inc. and the Lafarge Group) ground calcium aluminate cement from imported clinker at Norfolk, Va.

SLAG CEMENT

Slag cement has not been manufactured in the United States since 1972. Some shipments of slag cement were made from stocks at mills during 1973, but no slag cement shipments were made in 1974 and 1975. The last plants to produce slag cement—Martin Marietta Cement at North Birmingham, Ala., and Cheney Lime & Cement Co. at Allgood, Ala.—experienced considerable difficulty obtaining granulated slag from steel mills and were unable to purchase an adequate supply.

ENERGY

The cement industry has been more seriously affected than most other industries by the severe shortages of natural gas and oil, as it is one of the Nation's most energy-intensive industries, the sixth largest consumer, and has by far the highest energy costs. Expressed as a percentage of the total cost of materials, energy amounts to 35% to 40% of the total manufacturing cost. As a result, the conversion of plants to coal firing is going ahead rapidly, and several companies are opening their own coal mines or obtaining preferential rights to coal as a backup fuel by investment or long-term contracts. In 1975 the industry also made substantial strides in increasing the efficiency of its plants by the installation of energy- and fuel-saving kilns, mills, and other process equipment.

Fossil fuel energy consumed by the cement industry to produce 1 ton of clinker ranged from 3.5 million Btu to 11.8 million Btu and averaged 6.05 million Btu. Very little improvement, if any, was made in 1975 compared with 1974. An additional 1.52 million Btu in electrical energy (142.5 kilowatt-hours per ton was required in the production of 1 ton of portland cement, mostly for grinding. Based on information from the Energy Research and Development Administration, the Federal Power Commission calculated an average heat rate of 10,660 Btu per net kilowatt-hour from national average heat rates for fossil-fueled steam-electric plants. So the total energy used to produce 1 ton of portland cement in 1975 averaged 7.57 million Btu. The average fuel used in producing 1 ton of clinker at an inefficient wet-process plant was almost four times that in an efficient dry-process plant.

This illustrates the fuel conservation improvement potential of the cement industry. With the cost of fuel running 35% to 40% of the total cost of clinker production, and the great disparity between fuel consumption in 435 kilns operating in the United States and Puerto Rico in 1975, there is a long way to go before it can be properly said that the cement industry is energy efficient, in addition to being energy intensive.

Amcord, Inc., in 1975 became the first major western cement producer to convert to coal as its prime energy source by purchasing a coal mining operation in northern New Mexico for its Clarkdale, Ariz. plant.

In the three cement plants of the California Portland Cement Co., coal can now be burned. Much of the production of a wholly owned subsidiary, the Soldier Creek Coal Co. in Price, Utah, was being shipped to the company's three cement plants.

The Flintkote Co. had plans well underway for the installation of coal handling, storage, and burning facilities at its two California plants. Total cost will be $4 million.

The conversion of General Portland, Inc.'s plants to alternate fuel has been very costly. By the end of 1975 the company had four cement plants operating with coal as primary fuel, and three others had coal-burning facilities as alternate systems.

Ideal Basic Industries, Inc. at a cost of $9 million had coal-burning facilities operational at 6 of its plants, and by 1977 will have only 1 plant out of 13 wholly dependent on oil or gas.

Kaiser Cement & Gypsum Corp.'s San Antonio plant was being equipped to burn coal as a primary fuel at a cost of $2 million. Programs were also initiated to convert the company's four other cement plants to coal use, with a total estimated cost of $15 million.

Marquette Co.'s subsidiary, Southern Energy Resources Co., began coal mining operations in southern Tennessee, principally to supply coal for its plants in Tennessee and Georgia.

Medusa Cement Co. finished installing a new dry-process preheater kiln in its Georgia plant. It now uses 44% less energy per ton than in 1974. New chain sections in its kilns at Wampum and York, Pa., now compare favorably with dry-process plants without preheaters.

Missouri Portland Cement Co. claimed substantial fuel savings from maximum recycling of kiln heat previously wasted. Expenditures to accomplish this were more than justified.

Oregon Portland Cement Co. started converting its Lake Oswego plant to coal. It will be ready in early 1976 and will enable the plant to use either natural gas, Bunker C fuel oil, or coal.

Southwestern Portland Cement Co. installed facilities for the use of petroleum coke at its El Paso plant. Other plants already had backup facilities for burning coal. Of energy interest, its Victorville plant claimed equal costs for coal, gas, and fuel oil. At its Fairborn plant, substantial savings resulted from utilization of waste gas to preheat incoming feed.

Table 9.—Clinker produced in the United States, by kind of fuel [1]

Year and fuel	Clinker produced: Plants active during year	Clinker produced: Quantity (thousand short tons)	Clinker produced: Percent of total	Fuel consumed: Coal [2] (thousand short tons)	Fuel consumed: Oil (thousand 42-gallon barrels)	Fuel consumed: Natural gas (thousand cubic feet)
1974:						
Coal	42	[3] 19,298	24.8	4,724	--	--
Oil	10	[3] 5,801	7.4	--	5,465	--
Natural gas	27	[3] 10,980	14.1	--	--	70,246,514
Coal and oil	16	8,465	10.9	1,367	2,604	--
Coal and natural gas	33	12,950	16.6	1,516	--	47,330,734
Oil and natural gas	31	15,313	19.6	--	1,902	74,842,814
Coal, oil, natural gas	9	5,170	6.6	487	339	15,962,214
Total	168	[4] 77,978	100.0	8,094	10,310	208,382,276
1975:						
Coal	36	[3] 14,101	21.9	3,326	--	--
Oil	9	[3] 3,289	5.0	--	3,083	--
Natural gas	18	[3] 5,709	8.9	--	--	36,336,640
Coal and oil	21	8,887	13.8	1,651	1,743	--
Coal and natural gas	42	14,568	22.6	2,006	--	46,343,576
Oil and natural gas	27	11,569	17.9	--	1,863	59,972,545
Coal, oil, natural gas	15	6,416	9.9	585	642	16,907,095
Total	168	64,539	100.0	7,568	7,331	159,559,856

[1] Includes Puerto Rico.
[2] Includes 0.5% anthracite, 96.1% bituminous, and 3.4% petroleum coke in 1974; and 0.1% anthracite, 94.7% bituminous, and 5.2% petroleum coke in 1975.
[3] Average consumption of fuel per ton of clinker produced as follows: 1974—coal, 0.24491 ton; oil, 0.942 barrel; and natural gas, 6,398 cubic feet. 1975—coal, 0.23587 ton; oil, 0.937 barrel; and natural gas, 6,365 cubic feet.
[4] Data do not add to total shown because of independent rounding.

Table 10.—Clinker produced and fuel consumed by the portland cement industry in the United States, by process [1]

Year and process	Clinker produced: Plants active during year	Clinker produced: Quantity (thousand short tons)	Clinker produced: Percent of total	Fuel consumed: Coal [2] (thousand short tons)	Fuel consumed: Oil (thousand 42-gallon barrels)	Fuel consumed: Natural gas (thousand cubic feet)
1974:						
Wet	100	44,977	57.7	4,375	7,846	139,045,793
Dry	63	30,244	38.8	3,405	2,274	59,655,237
Both	5	2,758	3.5	314	190	9,681,246
Total	168	[3] 77,978	100.0	8,094	10,310	208,382,276
1975:						
Wet	98	36,413	56.4	4,215	5,554	104,983,678
Dry	64	25,179	39.0	3,182	1,681	42,973,033
Both	6	2,947	4.6	171	96	11,603,145
Total	168	64,539	100.0	7,568	7,331	159,559,856

[1] Includes Puerto Rico.
[2] Includes 0.5% anthracite, 96.1% bituminous, and 3.4% petroleum coke in 1974; and 0.1% anthracite, 94.7% bituminous, and 5.2% petroleum coke in 1975.
[3] Data do not add to total shown because of independent rounding.

Table 11.—Electric energy used at portland cement plants in the United States, by process [1] [2]

Year and process	Electric energy used: Generated at portland cement plants: Active plants	Generated at portland cement plants: Quantity (million kilowatt-hours)	Purchased: Active plants	Purchased: Quantity (million kilowatt-hours)	Total: Quantity (million kilowatt-hours)	Total: Percent	Finished cement produced (thousand short tons)	Average electric energy used per ton of cement produced (kilowatt-hours)
1974:								
Wet	4	135	98	5,700	5,835	54.6	45,727	127.6
Dry [3]	7	499	70	3,938	4,437	41.5	31,042	142.9
Both	1	11	5	401	412	3.9	2,717	151.6
Total	12	645	173	10,039	10,684	100.0	79,486	134.4
Percent of total electric energy used	--	6.0	--	94.0	--	--	--	--
1975:								
Wet	4	115	96	4,958	5,073	53.3	37,598	134.9
Dry [3]	6	523	70	3,497	4,020	42.2	26,248	153.2
Both	--	--	6	426	426	4.5	2,949	144.4
Total	10	638	172	8,881	9,519	100.0	[4] 66,796	142.5
Percent of total electric energy used	--	6.7	--	93.3	--	--	--	--

[1] Includes grinding plants and white cement facilities.
[2] Includes Puerto Rico.
[3] Includes data for grinding plants, eight in 1974; seven in 1975.
[4] Data do not add to total shown because of independent rounding.

TRANSPORTATION

Cement was transported from manufacturing plants in bulk or in containers by truck, rail, or waterway. Of the 67,183,000 tons of portland cement shipped from plants in the United States, 51,605,000 tons was sent directly to customers from producing plants and 15,578,000 tons was transferred to distribution facilities strategically located in principal market areas for customer delivery by short-haul truckloads. Although trucks were used to haul 86% of the portland cement to ultimate customers, they accounted for only 5% of the total cement transferred from plants to terminals. Manufacturers continued to use the railroads and waterways almost equally as the principal means of supplying distribution centers—7,222,000 tons by rail and 7,502,000 tons by water.

In the latter part of 1975 over 400 vessels laden with cement were reported waiting to discharge their cargo in the port of Apapa, Nigeria. Some efforts were being made to control the number of vessels charted, but the worst port congestion in the world had been created. Indications were that the vessels would have to wait up to 500 days to complete discharge, with demurrage rates a critical factor. Cement fixtures to Apapa were still being reported during this time—for example, Poland to Nigeria for 10,000 tons was fixed at $19.00 per ton, with a demurrage rate of $3,300 per day, after expiry of the normal discharge time allowed at 1,000 tons per day. A few vessels were being fixed on time charter at rates of $4,000 per day for 15,000-ton vessels.

The freight situation in the Arabian Gulf seemed under control, handling considerably more volume with minimum delays.[4]

[4] Industrial Minerals. Freights: Early Positions Firmer. No. 97, October 1975, p. 43.

Table 12.—Shipments of portland cement from mills in the United States, in bulk and in containers, by type of carrier [1]

(Thousand short tons)

Year and type of carrier	Shipments from plants to terminal		Shipments to ultimate consumer: From terminal to consumer		Shipments to ultimate consumer: From plant to consumer		Total shipments
	In bulk	In containers	In bulk	In containers	In bulk	In containers	
1974:							
Railroad	7,010	205	995	16	9,551	836	11,398
Truck	719	73	16,973	725	44,704	4,601	67,003
Barge and boat	8,815	18	120	--	932	3	1,055
Unspecified [2]	--	--	3	4	17	2	26
Total	16,544	296	18,091	745	55,204	5,442	[3] 79,482
1975:							
Railroad	7,023	199	940	121	7,214	259	8,534
Truck	775	79	14,241	831	39,035	4,354	58,461
Barge and boat	7,485	17	36	--	641	--	677
Unspecified [2]	--	--	--	--	99	3	102
Total	15,283	295	15,217	952	46,989	4,616	[3 4] 67,776

[1] Includes Puerto Rico.
[2] Includes cement used at plant.
[3] Bulk shipments were 92.2% (73,295 tons), and container (bag) shipments were 7.8% (6,187 tons) for 1974. Bulk shipments were 92.0% (62,206 tons), and container (bag) shipments were 8.0% (5,568 tons) for 1975.
[4] Data do not add to total shown because of independent rounding.

Table 13.—Cement shipments, by destination and origin [1]

(Thousand short tons)

	Portland cement [2]		Masonry cement	
	1974	1975	1974	1975
Destination:				
Alabama	1,311	1,146	104	97
Alaska [3]	86	131	W	W
Arizona	1,385	1,086	W	W
Arkansas	883	802	66	64
California, northern	3,134	2,651	--	--
California, southern	4,645	4,196	1	1
Colorado	1,339	1,162	34	24
Connecticut [3]	742	624	15	13
Delaware [3]	180	122	8	7
District of Columbia [3]	330	247	17	9
Florida	4,984	3,190	343	214
Georgia	2,227	1,542	178	143
Hawaii	505	463	14	13
Idaho	418	393	1	3
Illinois	3,593	3,281	117	101
Indiana	1,730	1,543	111	98
Iowa	1,763	1,739	29	26
Kansas	1,146	1,122	29	26
Kentucky	1,019	893	101	95
Louisiana	2,365	2,191	61	59
Maine	257	274	12	11
Maryland	1,385	1,106	105	90
Massachusetts [3]	1,188	914	44	34
Michigan	3,027	2,344	153	131
Minnesota	1,721	1,474	51	45
Mississippi	911	813	66	56
Missouri	1,715	1,635	43	39
Montana	269	253	3	3
Nebraska	1,115	899	15	14
Nevada	369	366	(4)	(4)
New Hampshire [3]	242	209	11	11
New Jersey [3]	1,928	1,443	66	51
New Mexico	586	540	15	15
New York, eastern	719	584	31	26
New York, western	1,119	905	55	45
New York, metropolitan [3]	1,629	1,070	42	33
North Carolina	1,728	1,357	227	194
North Dakota [3]	322	372	8	8
Ohio	3,327	2,848	203	179
Oklahoma	1,474	1,186	56	49
Oregon	825	774	1	1
Pennsylvania, eastern	2,055	1,760	74	67
Pennsylvania, western	1,142	1,014	79	79
Puerto Rico	1,762	1,470	(4)	--
Rhode Island [3]	175	140	5	5
South Carolina	1,066	800	131	109
South Dakota	344	313	10	9
Tennessee	1,646	1,326	174	153
Texas	6,359	6,130	165	158
Utah	684	691	1	1
Vermont [3]	120	109	6	5
Virginia	2,176	1,602	195	154
Washington	1,167	1,032	7	7
West Virginia	672	568	38	41
Wisconsin	1,621	1,551	64	54
Wyoming	245	317	3	3
Total United States	80,875	68,713	3,388	2,873
Foreign countries [5]	250	365	72	56
Total shipments	81,125	69,078	3,460	2,929
Origin:				
United States [6]	75,877	65,230	3,370	2,869
Puerto Rico	1,988	1,566	--	--
Foreign: [7]				
Domestic producers	1,617	980	62	39
Others	1,643	1,302	28	21
Total shipments	81,125	69,078	3,460	2,929

W Withheld to avoid disclosing individual company confidential data; included with "Foreign countries."

[1] Includes cement produced from imported clinker and imported cement shipped by domestic producers, Canadian cement manufacturers, and other importers. Includes Puerto Rico.

[2] Excludes cement (1974—440; 1975—384) used in the manufacture of prepared masonry cement.

[3] Has no cement-producing plants.

[4] Less than 500 short tons.

[5] Direct shipments by producers to foreign countries and U.S. possessions and territories; includes States indicated by symbol W.

[6] Includes cement produced from imported clinker by domestic producers (1974—1,904; 1975—1,240).

[7] Imported cement distributed by domestic producers, Canadian cement manufacturers, and other importers. Origin of imports withheld to avoid disclosing individual company confidential data.

Table 14.—Portland cement shipments in 1975, by type of customer[1]

(Thousand short tons)

District origin	Building material dealers		Concrete product manufacturers		Ready-mixed concrete		Highway contractors		Other contractors		Federal, State, and other government agencies		Miscellaneous including own use		Total[2]
	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	
New York and Maine	313	8.4	597	16.1	2,629	71.1	77	2.0	44	1.1	1	(3)	37	1.0	3,697
Eastern Pennsylvania	426	10.4	1,001	24.5	2,331	57.1	231	5.6	45	1.1	4	(3)	38	.9	4,076
Western Pennsylvania	191	10.9	254	14.6	1,014	58.3	242	13.9	32	1.8	--	--	5	.2	1,738
Maryland and West Virginia	121	6.6	425	23.3	1,195	65.7	32	1.7	33	1.8	10	0.5	--	--	1,817
Ohio	124	5.2	439	18.5	1,589	67.2	181	7.6	14	.5	--	--	16	.6	2,364
Michigan	250	5.4	646	14.1	2,510	54.8	879	19.2	223	4.8	13	.2	52	1.1	4,573
Indiana, Kentucky, Wisconsin	291	9.5	520	17.1	1,933	63.6	239	7.8	36	1.1	3	(3)	16	.5	3,039
Illinois	129	9.3	111	8.0	916	66.6	168	12.2	48	3.4	--	--	1	(3)	1,374
Tennessee	94	8.2	227	19.9	699	61.5	32	2.8	23	2.0	53	4.6	7	.6	1,136
Virginia, North Carolina, South Carolina	136	5.7	352	14.7	1,696	71.2	164	6.8	25	1.0	7	.2	2	(3)	2,382
Georgia	82	9.9	186	22.4	416	50.2	118	14.2	22	2.6	4	.4	1	.1	828
Florida	271	15.7	222	12.8	992	57.6	147	8.5	71	4.1	14	.8	4	.2	1,721
Alabama	129	6.5	300	15.2	1,173	59.6	154	7.8	147	7.4	9	.4	55	2.7	1,968
Louisiana and Mississippi	121	8.7	89	6.4	779	56.1	120	8.6	195	14.0	54	3.8	30	2.1	1,388
Minnesota, South Dakota, Nebraska	86	5.6	130	8.5	960	62.8	293	19.1	32	2.0	--	--	27	1.7	1,527
Iowa	105	4.6	426	18.8	1,409	62.4	272	12.0	30	1.3	2	(3)	12	.5	2,258
Missouri	104	2.6	397	10.0	2,998	75.6	421	10.6	37	.9	--	--	4	.1	3,962
Kansas	119	6.4	147	8.0	1,262	68.8	121	6.6	113	6.1	--	--	69	3.7	1,832
Oklahoma and Arkansas	173	7.7	211	9.4	1,330	59.3	412	18.3	65	2.9	2	(3)	49	2.1	2,240
Texas	577	8.0	679	9.4	4,538	63.1	368	5.1	609	8.4	100	1.3	324	4.5	7,195
Wyoming, Montana, Idaho	38	3.9	63	6.5	711	73.7	30	3.1	93	9.6	8	.8	21	2.1	964
Colorado, Arizona, Utah, New Mexico	206	6.2	359	10.8	2,216	66.7	158	4.7	237	7.1	6	.1	139	4.1	3,322
Washington	62	5.4	223	19.4	731	63.7	26	2.2	49	4.2	2	.1	54	4.7	1,147
Oregon and Nevada	65	7.3	70	7.9	611	69.1	102	11.5	18	2.0	9	1.0	7	.7	883
Northern California	184	7.7	266	11.2	1,697	71.8	94	3.9	101	4.2	4	.1	17	.7	2,362
Southern California	440	8.8	628	12.6	3,369	67.8	264	5.3	190	3.8	16	.3	57	1.1	4,964
Hawaii	21	4.6	47	10.3	359	78.7	11	2.4	17	3.7	--	--	1	.2	456
Puerto Rico	497	31.4	221	13.9	677	42.7	112	7.0	48	3.0	25	1.5	2	.1	1,582
Imports[4]	26	2.6	127	12.9	767	78.2	35	3.5	12	1.2	--	--	13	1.3	980
Total[2]	5,383	7.9	9,363	13.8	43,507	64.2	5,503	8.1	2,610	3.9	346	.5	1,063	1.6	67,776

[1] Includes Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than 0.1%.
[4] Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing individual company confidential data.

Table 15.—Portland cement shipped from plants in the United States, by type [1]

(Thousand short tons and thousand dollars)

Type	1974			1975		
	Quantity	Value [2]	Average per ton	Quantity	Value [2]	Average per ton
General use and moderate heat (Types I and II)	73,474	1,927,557	$26.23	62,816	1,924,202	$30.63
High-early-strength (Type III)	2,596	71,423	27.51	2,107	69,085	32.79
Sulfate-resisting (Type V)	323	8,653	26.79	346	12,236	35.36
Oil well	989	27,667	27.97	1,120	37,249	33.26
White	474	26,697	56.32	365	27,323	74.86
Portland slag and portland pozzolan	672	16,843	25.06	315	9,584	30.43
Expansive	132	4,681	35.46	92	3,856	41.91
Miscellaneous [3]	822	24,385	29.67	617	23,484	38.06
Total or average	79,482	2,107,906	26.52	[4] 67,776	[4] 2,107,020	31.09

[1] Includes Puerto Rico.
[2] Mill value is the actual value of sales to customers, f.o.b. plant, less all discounts and allowances, less all freight charges to customer, less all freight charges from producing plant to distribution terminal if any, less total cost of operating terminal if any, less cost of paper bags and pallets.
[3] Includes waterproof cement (1974–75), and low-heat (Type IV) and regulated fast setting (1975).
[4] Data do not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Shipments of cement into various States are considered to be an index of consumption. Portland cement consumption decreased 15% below that of 1974. Consumption shown in table 13 decreased in all but five States and shipping districts. The largest decrease was in Florida, with 1,794,000 tons; followed by Georgia, 685,000 tons; Michigan, 683,000 tons; Virginia, 574,000 tons; and metropolitan New York, 559,000 tons. The largest increase was in Wyoming with 72,000 tons, followed by North Dakota with 50,000 tons, and Alaska with 45,000 tons.

Producers of ready-mix concrete were the primary customers for portland cement, receiving 64.2% of total shipments. Concrete product manufacturers used 13.8% of the cement to make concrete blocks, concrete pipes, precast-prestressed concrete, and other concrete products. Direct shipments to highway contractors amounted to 8.1% of the total cement consumed during the year. Building materials dealers received 7.9% of the shipments, other contractors received 3.9%, Federal, State, and other government agencies purchased 0.5%, and 1.6% went for miscellaneous uses.

New housing unit starts, public and private, in 1975 were 13% below those in 1974; however, because of inflation, the value of new construction put in place was down only 0.5%. Private construction value decreased 7% below that of 1974, while value of public construction increased 6%. Residential construction value was down 16% for single unit and multiunit housing combined. Value of total private-nonresidential building was down 11%. Farm construction (other than residential), was off 25%; office buildings, 19%; other commercial buildings, 20%; telephone and telegraph buildings, 14%; and educational buildings, 13%. Private public utilities construction value was up 8%, led by petroleum pipelines, 210%; railroads, 18%; and gas, 16%. Total value of new public construction advanced 6%, with the following significant increases: Industrial, 20%; military facilities, 18%; sewer systems, 17%; conservation and development, 15%; hospitals, 10%; and other public buildings, 9%.

PRICES

The average mill value[5] of portland cement (all types) was $31.09 per ton in 1975, an increase of $4.57 per ton. Mill values for cement districts ranged from a low of $26.27 in New York and Maine to

[5] Mill value is the actual value of sales to customers f.o.b. plant, less all discounts and allowances, less all freight charges to customer, less all freight charges from producing plant to distribution terminal if any, less total cost of operating terminal if any, less cost of paper bags and pallets.

highs of $36.33 in Florida, $43.73 in Hawaii, and $38.54 in Puerto Rico.

The Bureau of Mines collects mill value for cement shipments but does not canvass cement prices. However, according to Engineering News-Record, December bulk-mill prices ranged from $27 in Northampton, Pa., to $72 in Anchorage, Alaska. Bagged cement prices were $6 to $8 per ton higher than bulk prices. All prices were subject to cash discounts. Base prices for portland cement in carload lots f.o.b. were reported monthly in Engineering News-Record for 20 cities in the United States. The December 1975 average for bulk cement was $37.50 per ton, compared with $33.45 in December 1974. In the 20-city survey, bulk prices ranged from a low of $33.65 per ton in Dallas, Tex., to highs of $40.30 per ton in Minneapolis, Minn., and $44.30 per ton in San Francisco, Calif. Masonry cement averaged $55.71 per ton in December 1975 and ranged from $46.57 per ton in Pittsburgh, Pa., to $74.29 per ton in Kansas City, Kans.

On May 12 and July 1, 1975, the Puerto Rican Department of Consumer Affairs approved increases in the price of a bag of cement at the producer's level in the amount of 15.41 and 16.01 cents, respectively. The price of bagged cement for the years ended December 31, 1975, 1974, and 1973 was $2.6884, $2.2390, and $1.6000, respectively; for bulk cement the price was $2.3884, $1.9790, and $1.6000 per bag equivalent. During 1975, overall construction continued to lag and cement consumption declined, reflecting the Island's economic recession. The private housing sector in particular was seriously depressed, being affected by tight money, high interest rates, and a large housing inventory. Export sales totaled 2.4 million bags in 1975, compared with 4.8 million bags in 1974.

Continued increases in fuel prices and inflation rates, much higher (18%) than in the United States, were responsible for substantial increases in world cement prices. A sampling of increases above 1974 cement prices for selected countries follows: The United Kingdom, 40%; Norway, 30%; Australia, 22%; the Netherlands, 19%; France, 17%; Luxembourg and Finland, 15%. While the price was unchanged in Greece and Turkey, it was probably State-controlled.

Table 16.—Average mill value in bulk, of cement in the United States [1]

(Per short ton)

Year	Portland cement	Prepared masonry cement [2]	All classes of cement
1971	$18.74	$25.28	$19.01
1972	20.31	26.52	20.59
1973	21.88	29.43	22.23
1974	26.52	32.93	26.79
1975	31.09	38.90	31.41

[1] Includes Puerto Rico.
[2] Masonry cement made at cement plants only.

FOREIGN TRADE

Hydraulic cement exported from the United States increased 70% in quantity, and the value almost doubled. In relative importance, cement exports amounted to less than 0.7% of the quantity and 1.3% of the value of total domestic shipments. Six countries—Canada, Mexico, the Dominican Republic, Leeward and Windward Islands, Venezuela, and the Netherlands Antilles—received 94% of the 494,100 tons of cement valued at $28,409,000 exported to over 80 countries.

Portland cement and clinker imported from 17 countries for consumption in the United States and Puerto Rico decreased 35% in quantity and 31% in value compared with 1974, and was 45% below the record 1973 imports. Nevertheless, despite a 15% decrease in domestic production caused by a continuation of the general economic recession, imports comprised 5% of total domestic cement shipments. Nearly 50% of the imports entered at customs districts in Florida (23.0%) and New York (25.9%).

Canada continued to be the leading exporter to the United States, supplying 49% of the imported cement and clinker, followed by Norway with 10%; Bahamas, 9%; and France and Spain, 8% each.

Clinker comprised 33% of the total imports in 1975, compared with 32% in 1974, 41% in 1973, and 34% in 1972. Four plants operated exclusively on imported clinker—one each in Michigan, Florida, Virginia, and Wisconsin. An additional 12 plants supplemented cement production by grinding imported clinker.

While imports comprised 5% of domestic shipments, total imports of 3.7 million tons exceeded the quantity of cement manufactured in each individual producing State with the exception of five States—California, Texas, Pennsylvania, Michigan, and Missouri.

The rate of duty on white, nonstaining portland cement was 1.0 cent per hundredweight, including the weight of container; other hydraulic cement and clinker were duty free, as granted in the final stage of the Kennedy round of trade negotiations under the General Agreement on Tariffs and Trade. However, the statutory import duty from countries that do not have most-favored-nation status was 8 cents per hundredweight for white, nonstaining portland cement and 6 cents per hundredweight for other hydraulic cement and clinker.

World trade in cement and clinker was about 30 million tons, compared with 766 million tons of total world production.

Table 17.—U.S. exports of hydraulic cement, by country

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Afghanistan	--	--	--	--	661	$31
Austria	85	$18	152	$37	4,671	147
Australia	554	27	269	32	212	87
Bahamas	1,514	94	4,184	230	1,666	135
Belgium-Luxembourg	98	24	169	43	391	71
Belize	--	--	483	26	269	14
Bermuda	269	20	75	20	49	12
Brazil	381	20	120	47	2,117	185
Canada	168,182	3,635	125,824	6,008	274,236	16,105
Chad	564	26	--	--	--	--
Chile	707	42	108	19	22	14
Costa Rica	646	28	51	17	77	71
Dominican Republic	16,045	269	48,941	1,072	34,862	788
Ecuador	266	12	751	53	428	73
Egypt	--	--	3	2	222	17
El Salvador	25	1	21	3	351	25
Ethiopia	564	29	--	--	--	--
France	436	30	131	33	165	43
French West Indies	966	11	1,086	23	728	19
Germany, West	374	60	103	30	105	44
Ghana	21	(1)	705	41	--	--
Guatemala	347	20	1,576	122	578	55
Haiti	48	5	1,005	27	37	10
Honduras	546	28	68	15	29	10
Hong Kong	91	19	100	19	124	30
Indonesia	1,200	86	1,721	95	3,061	2,407
Iran	3,081	149	46	18	39	53
Ireland	232	22	129	20	84	18
Italy	424	35	700	99	949	140
Jamaica	1,272	54	10,153	296	1,221	184
Japan	2,840	444	2,207	661	1,075	313
Korea, Republic of	318	33	86	28	143	63
Kuwait	260	7	16	11	12	11
Leeward and Windward Islands	17,173	174	15,419	308	23,498	651
Malagasy	475	23	--	--	--	--
Mauritania	475	21	--	--	--	--
Mexico	68,391	2,355	38,765	3,018	108,503	3,910
Morocco	--	--	--	--	811	58
Netherlands Antilles	23,601	249	16,067	334	6,791	212
New Guinea	1,140	51	--	--	--	--
Nicaragua	130	5	349	44	413	36
Niger	--	--	998	56	470	33
Norway	262	7	26	21	15	15
Oman	487	53	--	--	--	--
Pakistan	1,425	64	2	1	(1)	1
Panama	238	25	243	47	49	15
Peru	584	32	4,182	275	3,119	368
Philippines	207	35	1,710	151	67	18
Saudi Arabia	1,201	67	737	100	1,540	243
Singapore	299	30	5,126	244	126	35
South Africa, Republic of	140	19	118	30	168	59
Spain	198	32	119	30	114	63
Sweden	37	5	261	91	82	48
Switzerland	587	81	173	75	170	51
Taiwan	193	23	251	163	359	113
Trinidad and Tobago	365	22	82	29	62	94
Trust Territory of the Pacific Islands	905	38	60	3	354	17
Turkey	109	3	1	(1)	20	24
United Kingdom	436	54	434	91	338	120
Venezuela	1,298	113	985	202	16,120	589
Yugoslavia	93	20	348	87	552	142
Zaire	--	--	--	--	763	45
Other	1,935	131	2,405	313	1,044	274
Total	324,740	8,980	289,844	14,860	494,132	28,409

[1] Less than ½ unit.

Table 18.—U.S. imports for consumption of hydraulic and clinker cement, by country

(Thousand short tons and thousand dollars)

Country	1974		1975	
	Quantity	Value	Quantity	Value
Austria	(1)	(1)	--	--
Bahamas	830	20,015	349	9,229
Belgium-Luxembourg	20	1,035	14	722
Canada	2,245	37,149	1,819	33,951
Colombia	23	449	2	64
Denmark	1	61	15	413
France	315	5,246	312	6,237
Germany, West	267	4,338	30	491
Honduras	3	63	4	104
Japan	16	443	28	639
Mexico	220	2,993	148	2,535
Norway	678	11,589	365	6,127
Spain	271	4,773	301	4,602
Sweden	88	1,628	99	1,748
United Kingdom	662	10,069	214	3,629
Venezuela	91	1,766	--	--
Yugoslavia	2	117	2	129
Total	5,732	101,734	3,702	70,620

[1] Less than ½ unit.

Table 19.—U.S. imports for consumption of cement

(Thousand short tons and thousand dollars)

Year	Roman, portland, and other hydraulic cement		Hydraulic cement clinker		White nonstaining portland cement		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1973	3,914	67,450	2,743	35,501	29	1,177	6,686	104,128
1974	3,870	73,315	1,829	26,737	33	1,682	5,732	101,734
1975	2,474	49,286	1,207	20,218	21	1,116	3,702	70,620

Table 20.—U.S. imports for consumption of hydraulic and clinker cement by customs district, by country

(Thousand short tons and thousand dollars)

Customs district and country	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Anchorage:				
Canada	44	1,086	63	2,037
Japan	--	--	(1)	2
Total	44	1,086	63	2,039
Baltimore:				
Denmark	(1)	1	--	--
Germany, West	(1)	69	(1)	7
Total	(1)	70	(1)	7
Boston:				
Canada	(1)	1	--	--
Spain	--	--	18	143
Total	(1)	1	18	143
Bridgeport: Canada	1	16	--	--
Buffalo:				
Austria	(1)	(1)	--	--
Canada	657	10,200	582	10,491
Germany, West	--	--	(1)	5
Total	657	10,200	582	10,496
Chicago:				
Canada	49	882	27	526
United Kingdom	--	--	(1)	(1)
Total	49	882	27	526
Cleveland: Canada	47	1,032	33	816
Detroit:				
Canada	460	6,142	414	7,386
France	--	--	(1)	(1)
Spain	69	1,274	--	--
Total	529	7,416	414	7,386
Duluth: Canada	79	1,213	22	443
El Paso: Mexico	13	320	11	432
Galveston: United Kingdom	27	316	--	--
Great Falls: Canada	4	103	4	138
Honolulu: Japan	16	443	28	637
Houston:				
Canada	--	--	(1)	4
United Kingdom	140	2,148	72	1,195
Total	140	2,148	72	1,199
Laredo: Mexico	(1)	2	1	16
Los Angeles:				
Germany, West	(1)	6	(1)	9
Spain	(1)	16	(1)	16
Total	(1)	22	(1)	25
Miami:				
Bahamas	216	5,184	56	1,564
Belgium-Luxembourg	2	50	1	30
Canada	42	560	--	--
Germany, West	200	2,903	30	447
Mexico	--	--	22	292
Norway	292	5,530	110	2,061
Spain	73	1,031	119	1,721
Sweden	88	1,628	59	1,029
United Kingdom	364	5,545	46	675
Venezuela	10	196	--	--
Total	1,287	22,627	443	7,819
Milwaukee: Canada	46	1,289	52	771
New Orleans: United Kingdom	108	1,710	96	1,710
New York City:				
France	--	--	(1)	1
Germany, West	(1)	8	--	--
Norway	386	6,059	255	4,066
Spain	--	--	11	198
Total	386	6,067	266	4,265
Norfolk:				
Bahamas	173	4,235	91	2,075
France	315	5,223	312	6,220
Spain	18	302	49	767
United Kingdom	23	349	(1)	48
Total	529	10,109	452	9,110
Ogdensburg:				
Canada	240	4,603	111	2,244
United Kingdom	(1)	1	--	--
Total	240	4,604	111	2,244
Pembina:				
Canada	119	2,577	93	2,293
United Kingdom	(1)	(1)	--	--
Total	119	2,577	93	2,293
Philadelphia:				
Bahamas	2	46	--	--
Germany, West	3	390	(1)	23
Yugoslavia	2	117	2	129
Total	7	553	2	152
Portland, Maine: Canada	62	1,086	44	901
St. Albans:				
Canada	126	2,795	101	2,280
United Kingdom	--	--	(1)	1
Total	126	2,795	101	2,281
San Francisco: Belgium-Luxembourg	--	--	(1)	1
San Juan:				
Belgium-Luxembourg	17	952	13	691
Colombia	--	--	2	64
Denmark	1	60	15	413
France	(1)	23	(1)	16
Germany, West	(1)	1	--	--
Honduras	--	--	2	62
Spain	12	580	32	746
Total	30	1,616	64	1,992
Savannah:				
Mexico	--	--	11	137
Spain	53	830	11	180
Total	53	830	22	317
Seattle: Canada	269	3,564	273	3,621
Tampa:				
Bahamas	439	10,550	202	5,590
Belgium-Luxembourg	1	33	--	--
Colombia	23	449	--	--
Germany, West	64	961	--	--
Honduras	3	63	2	42
Mexico	207	2,671	103	1,658
Spain	46	740	61	831
Sweden	--	--	40	719
Venezuela	81	1,570	--	--
Total	864	17,037	408	8,840
Grand total	5,732	101,734	3,702	70,620

[1] Less than ½ unit.

WORLD REVIEW

In 1975, about 1,700 clinker-producing cement plants in 140 countries were operating with an estimated total annual capacity of over 1 billion tons. In addition, more than 3,000 very small plants were reportedly operating in many communes and municipalities in the People's Republic of China, accounting for more than 50% of that country's estimated 30-million-ton capacity. Many new plants, plant expansions, and plant modernizations were under construction or in various stages of planning and financing throughout the world.

Recessions, fuel crises, inflated costs, and reduced product demand characterized most of the world's cement community in 1975. The several indicated bright spots on the international scene were those principally associated with oil-producing nations.

Special situations occurred: Some 250 cement-carrying vessels laid at anchor off Nigeria, nationalization of the cement industry occurred in Portugal, the first ship through the Suez Canal carried bagged cement, and an appreciable increase took place in attempted "deals" involving the sale and movement of large cement tonnages.

The year 1975 was a volatile one for cement, and on the whole it proved to be a difficult year for major countries from the point of view of usage and viability. However, a number of developing nations, particularly in the Near and Middle East, established expansion programs, the net result of which will surely change existing patterns of demand and supply.[6]

A construction slump in 19 European countries belonging to the European Cement Association (CEMBUREAU) [7] was responsible for a 4.4% decrease in cement production in 1975, the second decline in as many years and the first back-to-back decrease since World War II. Many kilns and some plants were taken out of production because of the depressed market. Nevertheless, six new plants with a combined annual capacity of 5.9 million tons started operation in member countries. An additional 15 new kilns went into production in existing plants with a combined additional annual capacity of 7.8 million tons. Ten kilns in new plants and 17 new kilns in plant expansions were under construction that will increase annual clinker production capacity by 19.0 million tons when completed in 1976 and 1977.

Cement price increases varied considerably in member countries, and average cement prices rose 25% following continued increases in fuel and power costs combined with the inflationary trend of all manufacturing cost items.

The combined output of the 19 member countries of CEMBUREAU amounted to 210 million short tons in 1975 as against 220 million tons in 1974, or a decrease of 4.4%. Comparable figures also indicated that apparent consumption decreased 5.7%. In 1975, CEMBUREAU per-capita cement consumption ranged from 249 kilograms (549 pounds) in Turkey to 913 kilograms (2,013 pounds) in Austria, and averaged 475 kilograms (1,047 pounds). Centrally planned economy countries, including the U.S.S.R., produced 210 million tons in 1975, an increase of 7.4% compared with 1974 output.

World production of cement in 1975 was estimated at 766 million tons, compared with 776 million tons in 1974. The five largest cement-producing countries in 1975 were the U.S.S.R., 134.5 million tons; Japan, 72.2 million tons; the United States, 69.7 million tons; Italy, 37.7 million tons; and West Germany, 36.9 million tons.

Western Europe (European Economic Community) maintained its leading position in the world cement industry by producing 210 million tons of cement in 1975, or 27.4% of the world total. Eastern Europe (including the U.S.S.R.) produced 25.7% of the world total; Asia, 25.0%; North and South America, 17.7%; Africa, 3.3%; and Oceania, 0.9%.

In the 1975 annual report of the Holderbank[8] group, represented by subsidiaries and affiliated companies in 17 countries, reduced cement consumption was reported in 13 countries, including Cyprus (down 45%), Switzerland (down 26%), Lebanon

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[6] Grancher, R. A. International Cement Review. Rock Products, v. 79, No. 4, April 1976, pp. 96–106.

[7] Organisation for Economic Co-operation and Development (OECD). Directorate for Science, Technology, and Industry. "Draft Statistical Report on the Cement Industry in 1975." Paris, Oct. 29, 1976, 19 pp.

[8] Holderbank Financiere Glaris Ltd. (Zurich, Switzerland). Annual Report, 1975, pp. 6–38.

(down 16%), and the United States (down 16%). This reduction was only partially offset by gains in the other four countries: Philippines, 24%; Brazil, 11%; Mexico, 10%; and Costa Rica, 9%. This resulted in an overall reduction of 18 million short tons, or 7.8%.

Polysius, A.G.[9] noted in its 1975 annual report the major shifts in its construction market. In the previous 10 years, the European market provided about 50% of their order intake; for 1975 it comprised only 12%. This was due to the continued shrinkage in the housing construction market in Europe. In the previous 10 years, Asia and Africa had 29% and 7% of their contracts, but for 1975, this increased to 55% and 27%, respectively. This was because of the lower growth rates for the highly industrialized countries, whereas in the developing countries, there was a strong and increasing demand for cement. Additionally, it is the Organization of Petroleum Exporting Countries (OPEC) nations with their increased foreign exchange income that can proceed rapidly toward industrial development. In the near future, their present high level of cement imports will be reduced by production from their new facilities.

Afghanistan.—The Ghori and Jabal Siraj cement plants produced a total of 154,000 tons per year, of which 40% was exported to the U.S.S.R. and Iran. Capacity of the Ghori plant was to be expanded from 130,000 to 330,000 tons per year. Construction of two additional plants at Herat and Kandahar was being planned.[10]

Algeria.—At least three major cement plant construction programs were underway through contracts signed by Société National Materiaux de Construction (SNMC), Algeria's state corporation for public construction. At Zahana, 21 miles southeast of Oran, Société Fives-Cail Babcock was building a 1.2 million-short-ton-per-year dry facility, which was an extension of the present plant. This will be one of the world's most modern, with an 18- by 275-foot rotary kiln, a four-stage preheater with cyclones, a 130-ton-per-hour hammer mill, and a 165-ton-per-hour rod mill for the clinker, and is planned to be onstream in 1977.

A new, fully integrated, 1 million-ton-per-year plant at El Asnam, about 150 miles from Algiers, was being constructed for SNMC by Kawasaki Heavy Industries, Ltd., and Marubeni Corp. of Tokyo. Daily production was to be 3,300 tons of portland cement and sulfuric-acid-resistant cement. Suspension preheating, fully automated operation at all stages, and computerized process control were features of the plant design. Operation was scheduled to begin by late 1978 or early 1979.

SNMC has also announced a 550,000-ton-per-year cement plant at Saida, to be built by Kawasaki Heavy Industries, Ltd. This installation is scheduled to be completed by late 1977 and in full operation by 1978. Contracts have also been awarded by SNMC for plants to be built at Constantine and Beni Saf.

SNMC's stated objective for the Algerian cement industry is to raise production to a 10.5-million-ton-per-year level by 1980.[11]

Australia.—Adelaide Brighton Cement Ltd. was doubling the capacity of its Port Adelaide, South Australia, plant, with a 550,000-ton-per-year, 50- by 220-foot, four-stage suspension preheater kiln, a Loesche roller mill, and electrostatic precipitators. The plant was expected to start operations in 1976. Blue Circle Southern Cement Ltd. was seeking tenders for an 830,000-ton-per-year expansion of its plant at Berrima, New South Wales.[12]

Belgium.—Belgian cement consumption in 1975 amounted to 6.4 million tons, down 3.4% from 1974, and because of its 12.4% inflation for the year, suffered a 27% reduction in its export sales of cement and clinker.

Cimenteries CBR and ENCI-Belgique have completely computer-automated their new, 3,500-ton-per-day dry-process plant at Lixhe.[13]

Brazil.—Brazil's cement consumption rose in 1975 by about 11% to some 18.4 million tons, and the cement price was increased by 35%, proportional to the inflation.

The new Pedro Leopoldo plant of Ci-

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[9] Polysius, A.G., (Neubeckum, West Germany). Annual Report, 1975, pp. 11–12.
[10] Page 99 of work cited in footnote 6.
[11] Engineering News-Record. V. 194, No. 19, May 8, 1975, p. 54.
Levine, S. The International Cement Scene: Major Investments Shift to Middle and Far East. Pit and Quarry, v. 68, No. 7, January 1976, pp. 81–84.
Page 100 of work cited in footnote 6.
[12] Page 106 of work cited in footnote 6.
[13] Page 96 of work cited in footnote 6.
Page 21 of work cited in footnote 8.

mento Nacional de Minas S.A., with a capacity of 1.1 million tons per year, came onstream. This is the largest single cement-producing facility in Brazil, and is linked to the industrial triangle market area of São Paulo-Rio de Janeiro-Belo Horizonte by a rail distribution system.

Cimento Tupi started up a new plant in late 1975. Major equipment items included a 15- by 220-foot rotary kiln with a four-stage preheater, a 14- by 23-foot raw mill, a 12- by 37-foot finish mill, a clinker cooler, and blending equipment.

Cimento Santa Rita S.A., in São Paulo, was installing a 2,200-ton-per-day Allis-Chalmers suspension preheater with a 16- by 230-foot rotary kiln, a 190-ton-per-hour type MPS-3450 roller mill, and a 16- by 46-foot finish-grinding Compeb mill powered with a 6,000-horsepower drive—one of the largest of its type.

Cia. de Materials Sulfurosos' new 2,400-ton-per-day production line at its Montes Claros plant included an 800-ton-per-day EV crusher, a 16- by 22-foot Unidan mill for raw material grinding, a 17- by 263-foot kiln with twin four-stage suspension preheaters and planetary cooler, a 16- by 41-foot finish mill, and electrostatic filters.

At the Sobral, Ceara, plant of Cia. Cearense de Cimento Portland, S.A., a 1,100-ton-per-day expansion project involved a 14- by 224-foot kiln with a suspension preheater and a 14- by 23-foot raw mill with a 2,200-horsepower drive.[14]

Canada.—Canada's cement consumption was 9.8 million tons in 1975, an 8% decrease from 1974. Regional cement consumption reflected construction activity. Quebec consumption rose 1%, while Ontario consumption fell 11%.

Canada Cement Lafarge Ltd. was doubling capacity to 500,000 tons per year at its Brookfield, Nova Scotia, cement plant with a $24 million expansion. It was scheduled for completion in 1977. F. L. Smidth & Co. was supplying an 820-ton-per-day kiln and a 4,500-horsepower finish mill.

Ocean Cement Ltd. was planning a 1.1-million-ton-per-year plant at a cost of $90 million at Tilbury Island, British Columbia; the plant was scheduled to go onstream in 1978. Polysius will supply its DOPOL rotary kiln plant and a planetary cooler with an output of 3,500 tons per day, and a roller mill with a throughput capacity of 270 tons per hour. This is reportedly the largest clinker-producing plant with preheater kiln and roller mill in North America.

Scheduled for completion in 1976, St. Marys Cement Ltd. was doubling output capacity at its plant in St. Mary, Ontario, with a $30 million expansion project. A 500,000-ton-per-year, 15- by 325-foot rotary kiln with a four-stage suspension preheater will be installed.

Lake Ontario Cement Ltd.'s $15 million expansion program was completed in 1975. Doubling the plant's capacity, an 850,000-ton-per-year kiln with a four-stage preheater was installed.[15]

Chile.—In 1975, Chile was nearly self-sufficient in cement. The additional production of Chile's fourth cement plant, Industria Nacional del Cemento S.A., which opened in early 1975, eliminated the need for imports during 1975 and allowed modest quantities of exports to other Latin American countries. The Government of Chile announced it would return ownership of the industry to the private sector.[16]

China, People's Republic of.—The Chinese cement industry is becoming a world factor. Current output of 20 to 30 million tons yearly is catching up with that of the leading Western European countries and is continuing to rise. There are probably 50 or more plants capable of producing between 100,000 and 1 million tons yearly. There are over 3,000 so-called small cement plants in two sizes—ranging from 3,000 to 10,000 tons per year, and from 10,000 to 50,000 tons per year. These small plants have been very important in rural areas for local construction projects. The cement shipped to Hong Kong has been of reasonably good quality.[17]

Colombia.—For Colombia, 1975 was rather a poor year for building activity. Cement consumption was 3.1 million tons, a 12.9% decrease compared with 1974 use.

Polysius reported that the commissioning of the new slag and clinker grinding plant

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[14] Page 103 of work cited in footnote 6.
Page 33 of work cited in footnote 8.
Page 84 of second work cited in footnote 11.

[15] Page 26 of work cited in footnote 8.
Work cited in footnote 9.
Page 84 of second work cited in footnote 11.

[16] U.S. Embassy, Santiago, Chile. State Department Airgram A-107, June 25, 1975, p. 3.

[17] Wang, K.P. The People's Republic of China, A New Industrial Power With a Strong Mineral Base. Bureau of Mines Special Publication, 1975, 96 pp.

of Cementos Boyacá S.A. in Bogotá was further postponed because of transportation difficulties. It is now expected to come onstream in early 1976. Equipment included a 14- by 44-foot, 4,330-horsepower cement mill, a 25-foot-diameter air separator, and an 11- by 17-foot rapid dryer. This $7 million expansion program will raise the plant capacity from 360,000 to 520,000 tons per year.

Compañía Colombiana de Clinker S.A. was building a 2,200-ton-per-day wet-process two-line cement plant near Cartegena. Equipment included two kilns 15-1/2 by 13 by 500 feet, two stoker-type clinker coolers, two 2,000-horsepower raw-grinding Compeb mills, 10-1/2 by 39 feet, and two finish-grinding Compeb mills of different sizes.

Cementos del Caribe S.A. was installing a wet-process plant at its Barranquilla plant at Cali. Allis-Chalmers provided the major and ancillary equipment, including a 14- by 12-1/2- by 450-foot rotary kiln and a 7-1/2- by 71-foot air-quenching cooler.

Cementos del Valle S.A. has placed onstream a new 880-ton-per-day wet-process plant at Cali. Allis-Chalmers provided the major equipment for this coal-fired, wet-process plant, including a 14- by 12-1/2- by 450-foot rotary kiln, a 7-1/2- by 71-foot air-quenching cooler, and a dust recuperating and return system.[18]

Costa Rica.—Kaiser Engineers were involved with the Corporacion Costarricense de Desarolla on a prefeasibility study for the construction of a new $50 million cement plant with an annual capacity of 600,000 tons. Location will be at Colorado de Abangeres on the Gulf of Nicoya.[19]

Cyprus.—In spite of the difficulties arising from the political situation, the expansion of Cyprus Cement Co. Ltd.'s Moni plant at Limassol was completed in 1975. The new production line had a capacity of over 275,000 tons of cement per year. Even with the unsatisfactory domestic market, the total output was disposed of, with export sales of 255,000 tons in 1975, compared with 110,000 tons in 1974. The small balance of 43,000 tons was sold to the domestic market.[20]

Denmark.—A/S Aalborg Portland-Cement-Fabrik operated five plants in Denmark and produced 3 million tons of cement in 1975. In 1975 it became the country's sole producer, when the last independent operator joined the group. One of its major export products is white cement, which is shipped to over 60 countries throughout the world.[21]

Dominican Republic.—During 1975 647,000 tons of cement were produced by a State-owned company, with imports accounting for the remainder of the total domestic consumption of 810,000 tons. Two new cement plants scheduled to open soon (one mixed private-state, and the other private) should make the Dominican Republic a net exporter of cement during 1976.

Cementos Nacionales S.A. was building a new 510,000-ton-per-year dry-process plant near San Pedro de Marcoris, scheduled to be onstream in 1976. The Fuller Co. was supplying the major equipment items including a 15- by 220-foot rotary kiln with a four-stage preheater, a 12- by 33-foot raw mill, a 13- by 40-foot finish mill, a clinker cooler, dust collectors, and in-plant control panels.[22]

Ecuador.—La Cemento Nacional C.E.M. has signed a $10 million contract with Allis Chalmers for the construction of a 1,650-ton-per-day cement plant to be built 20 miles west of Guyaquil. Construction was initiated in 1975, and startup was scheduled for 1977.

Allis Chalmers was prime contractor for a cement manufacturing facility expansion near Guyaquil, planned by Comision de Valores-Corporacion Financiera Nacional (CV-CFN), a Government agency in Quito. The $13.5 million dry-process project was scheduled for completion in late 1978, and was the result of a feasibility study by the SNC Group Inc., Montreal, Canada, and conducted for La Comision de Valores of Ecuador, now the principal shareholder of Cementos Selvalegre.[23]

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[18] Page 104 of work cited in footnote 6.
Page 32 of work cited in footnote 8.
Page 84 of second work cited in footnote 11.
[19] Canada Commerce. V. 139, No. 12, December 1975, p. 35.
[20] Work cited in footnote 8.
[21] Industrial Minerals. No. 89, February 1975, p. 12.
[22] U.S. Embassy, San Domingo, Dominican Republic. State Department Airgram A-70, May 17, 1976, p. 6.
Page 104 of work cited in footnote 6.
Page 83 of second work cited in footnote 11.
[23] Engineering News-Record. V. 194, No. 7, Feb. 7, 1975, p. 50.
The Northern Miner. V. 61, No. 27, Sept. 18, 1975, p. 25.
Page 84 of second work cited in footnote 11.

Egypt.—The Ciment Portland Tourah plant was being expanded by an additional 800,000 tons per year. The $30 million project with F. L. Smidth & Co. called for a 16-1/2- by 263-foot rotary kiln with twin four-stage suspension preheaters and a planetary Unax cooler, a 770-ton-per-day EV crusher, a 16-1/2- by 22-foot Tirax Unidan mill for grinding raw material, and a 16-1/2- by 41-foot Unidan finish mill with a 6,850-horsepower Symetro drive. A natural gas and oil mixture was to be used as the plant's fuel source.

In early November 1975, the first vessel in 16 years to travel through the Suez Canal with Israeli-bound cargo carried some 8,500 tons of bagged cement. An agreement signed between Egypt and Israel provided that non-Israeli ships carrying nonstrategic material for Israel could use the canal. The Greek ship *Olympus* carried its Romanian cement through the waterway to the southern Israeli port of Eilat. A war-risk tariff had been set on the cement by a Tel Aviv insurance company which was nearly 27 times higher than the normal premium paid.[24]

France.—Sales of cement by French plants, including exports, were 34 million tons in 1975, an 8.1% decrease compared with 1974. Exports accounted for 2.3 million tons of cement or clinker, or about 7% of total sales. Construction work in 1975 was about 2.6% lower than in 1974.[25]

Germany, West.—West Germany's cement production in 1975 was 36.9 million tons, a 6.9% decrease compared with 1974. At the end of 1975, cement production capacity was 48.5 million tons, which indicated a 76% utilization of capacity for the year. No new plants or plant expansions occurred during the year. Exports for the year were 1.8 million tons. Residential construction and other construction work slackened during the year, and the expected economic upswing in West Germany failed to materialize in 1975.

Polysius A.G. received a contract from Dyckerhoff Cement for a 21-foot-diameter counterflow preheater rated at 660 tons per day of clinker for the production of white cement.[26]

Greece.—During 1975, Greek cement production capacity reached 10 million tons, and the cement industry invested about $62 million in new installations. Production of cement was 8.7 million tons, a 12% increase compared with 1974. Exports were particularly important, with 3.3 million tons exported to mostly Middle East and North African countries—a 50% increase compared with 1974.

A new cement plant, with a capacity of 1.1 million tons per year, went onstream in Kamari, Beotea the fourth 1.1-million-ton-per-year plant of Titan Cement Co. Construction continued on General Cement Co.'s 1.7-million-ton-per-year plant at Volos and on Chalkis Cement Co.'s 1.1-million-ton-per-year cement plant at Mikro Vathy, Aulis, near Khalkis. With the completion of these two plants, scheduled for 1976, the cement-producing capacity of Greece will be 12.1 million tons per year. The Government of Greece has authorized investments, totaling $300 million, in six new cement plants. No siting or capacities for new plants were mentioned.

The first cement plant to be built in Greece was in fact the first plant in the whole Balkan and Middle East area, and was erected by the Titan Cement Co., at Eleusis in 1911. There are now seven plants producing cement in Greece, operated by four companies; two more are under construction, and several more are planned.

Virtually all the cement produced in Greece (97% to 98%) is a gray portland cement with sometimes either 10% or 20% pozzolan (Santorini earth) added to make a Hellenic-type portland cement. Most producers have their own quarries for clay and limestone near the plants, but gypsum is shipped mainly from Crete and the Ionian Islands, while pozzolan comes from the Island of Thira.

M. A. Karageorgis, S.A., has contracted with Kaiser Engineers to handle engineering and construction management for a 1.1-million-ton-per-year, $43 million cement plant to be located at Messinia.[27]

Haiti.—Le Ciment d'Haiti, S.A. completed an expansion program at its plant at Fond Mombin, Commune de l'Arcahaie. The Fuller Co. supplied the major equipment to the project, including an 11- by

[24] Pages 101–102 of work cited in footnote 6.
Page 83 of second work cited in footnote 11.
[25] Page 19 of work cited in footnote 8.
[26] Page 98 of work cited in footnote 6.
Work cited in footnote 7.
Page 16 of work cited in footnote 8.
[27] Industrial Minerals. No. 75, December 1973, pp. 34, 36.
U.S. Embassy, Athens, Greece. State Department Airgram A–73, May 14, 1976, p. 8.
Page 84 of second work cited in footnote 11.

32-foot finish mill, an 18-foot-diameter air separator, pneumatic conveying equipment, and in-plant dust collectors.[28]

Hungary.—A new cement plant with an annual capacity of 1.7 million tons went onstream in 1975 at Hejöcsaba, a suburb of Miskolc, Hungary's second largest city and center of an industrial region. This plant has two production lines and was the largest newly erected cement plant in Eastern Europe. Since 1960, four major cement plants have been built in Hungary; the first two were 1.1-million-ton plants at Vac on the Danube north of Budapest in 1972, and the fourth, under construction at Bélapátfalva near the Czechoslovakian border, will be operational in 1978 and have a capacity of 1.3 million tons. Imports of cement have been amounting to over 1 million tons per year, 70% of which is supplied by the U.S.S.R. Once the Bélapátfalva plant is operational, Hungary expects to be self-sufficient in the cement category.[29]

Indonesia.—Kaiser Cement & Gypsum Corp.'s 51%-owned Indonesian affiliate, Cibinong Cement Co., placed onstream in 1975 a new cement plant at Cibinong, near Bogor, West Java. Initial rated capacity is 550,000 tons per year. The firm immediately embarked on a $48 million, 100% expansion project to be completed in 1977. The Fuller Co. will supply a 15- by 220-foot rotary kiln with a four-stage preheater.

Mitsui & Co., Ltd., and other Japanese and Indonesian interests announced initiation of construction of an integrated cement plant with a capacity of 660,000 tons per year at Cilacap in Central Java.

Early in 1975, the Asian Development Bank announced the loan of $37 million to Indonesia for a large cement plant at Baturaja, South Sumatra. This was the largest loan so far to Indonesia, in which the total cost, including local currency, was $57 million. Annual capacity will be 550,000 tons per year, and a special feature was that, while the clinker will be produced at Baturaja, the finish grinding and preparation will be at the two principal consuming-market areas of Palembang and Telukbetung. No further implementation was known.

The Government of Indonesia was planning a 1-million-ton-per-year cement plant expansion at Gresik, East Java. Cost was not disclosed, but the Export-Import Bank has approved a loan toward the project.[30]

Iran.—By the middle of 1976, operations are to be initiated at the 3-million-ton-per-year Isfahan slag cement plant located in the Kuhi-Rud highlands, 260 miles south of Teheran. Isfahan's production will double the current cement output of Iran's present 10 cement facilities. The plant will have two production lines, each with a designed clinker capacity of 3,600 tons per day. Granulated blast furnace slag from the neighboring iron and steel plant will be utilized. Isfahan's burning plant will involve some of the largest heat exchange rotary kilns with satellite coolers ever built. The kilns are 19 feet in diameter by 290 feet long and are equipped with four-stage twin-type Humboldt heat exchangers. Each kiln is fired with natural gas.

A new 770,000-ton-per-year cement plant was under construction near the Iranian winter resort of Abe-Ali, about 28 miles northeast of Teheran. The Shemal Cement Co., which belongs to the Teheran Cement Co., has stated that this plant will start early in 1978.

The Soufian Cement Co. was expanding its plant near Tabriz by a fourth production line of 2,200 tons per day. F. L. Smidth & Co. was supplying equipment, including a 3,950-horsepower raw mill, two 23-foot-diameter air separators, a 16-½- by 263-foot rotary kiln with a four-stage suspension preheater and planetary cooler, and a 4,550-horsepower finish mill.

Iran's Fifth Economic Development Plan called for a level of industrial output requiring substantial increases in its cement industry base. Production will have to rise from 4.0 million tons in 1975 to 22 million tons per year by the plan's completion.[31]

Iraq.—The Badoosh cement plant in northern Iraq was reportedly increasing production by 1,650 tons per day through the incorporation of the Polysius A.G.

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[28] Page 104 of work cited in footnote 6.
[29] Page 97 of work cited in footnote 6.
Work cited in footnote 9.
[30] Canada Commerce. International Projects. V. 139, No. 2, February 1975, unnumbered page.
Page 99 of work cited in footnote 6.
First work cited in footnote 11.
Pages 81–82 of second work cited in footnote 11.
[31] Rock Products. V. 78, No. 4, April 1975, p. 17.
———. V. 78, No. 5, May 1975, p. 51.
Page 102 of work cited in footnote 6.
Page 82 of second work cited in footnote 11.

dry-process system. The plant's original equipment, installed by Polysius some 20 years ago, consisted of two wet-process kilns with a capacity of 660 tons per day. New Polysius units included a 14- by 236-foot rotary kiln, a counterflow preheater, a raw mill, a finish mill, two air separators, and pneumatic conveying equipment.

F. L. Smidth & Co., Copenhagen, announced that the firm had received the largest single order in its 100-year history from the Republic of Iraq's Ministry of Industry. The $225 million contract called for the construction of a new four-kiln cement plant with a 2.2-million-ton-per-year capacity at Kufa, 112 miles south of Baghdad. Major equipment included four rotary kilns with Unax coolers, each with an output of 1,650 tons per day, four Unidan raw mills, three Sonex-Unidan cement mills, and six Fluxo packers. The plant was scheduled to commence production in stages, with full completion in 1978.

Société Fives-Cail Babcock reported it had signed a contract in Iraq for a cement plant with a capacity of 1,650 tons per day. Valued at $38 million, the project was scheduled to become operational in June 1977.

Iraq's Minister of Industry and Minerals reported at yearend that contracts for the construction of a cement plant with a capacity of 2.2 million tons per year would be awarded shortly in an effort to reach an overall production target of 7.7 million tons per year of cement by 1977. A 9.9-million-ton annual industry capacity was stated to be Iraq's cement goal for 1980.[32]

Ireland.—The recession in Ireland reached its low point in 1975, and recovery was slow. Stimulated by an increase in building activity during the latter part of 1975, cement sales in the third and fourth quarters increased 7% and 6%, respectively. Inflation was a serious problem throughout 1975, standing at 21% for the year.

Cement-Roadstone Holdings Ltd., Ireland's largest industrial company, announced that it was more than doubling the capacity of its Platin cement plant to 1.1 million tons per year. F. L. Smidth & Co. will supply a roller mill and an 18- by 290-foot, 3,300-ton-per-day dry-process kiln with planetary cooler and twin four-stage suspension preheaters. The project was expected to be completed by early 1978, with the new operation replacing the 38-year-old Drogheda cement works. Roadstone's decision to expand Platin was based on growth in Ireland's cement demand and developments in cement machinery and automation that made the Drogheda plant uncompetitive with the newer European facilities.[33]

Italy.—Estimated consumption of cement in Italy in 1975 was 37.4 million tons, compared with 39.7 million tons in 1974, a 6% reduction. Exports were also slightly less in 1975 with about 384,000 tons going mostly to non-EEC-member countries.

SpA Cementerie Calabro Lucane (Italcementi group) started up a new cement plant in 1975 at Castrovillari in southern Italy. Raw materials come from two quarries linked to the plant by a belt conveyor 6.2 miles long. An investment of $634,000 has been made in the mill. Its automated control systems are joined to a computer in a sister plant at Matera.[34]

Jamaica.—The Caribbean Cement Co. Ltd. initiated a $25 million expansion of its Rockfort plant to double capacity from 440,000 to 880,000 tons per year. Major Allis-Chalmers equipment included a 14- by 197-foot kiln and suspension preheater rated at 1,430 tons per day, a cooler, a 1,000-horsepower MPS roller mill rated at 130 tons per hour, and a 4,500-horsepower finish-grinding Compeb mill, 13- by 45 feet, rated at 123 tons per hour. As of the end of 1975, the expansion project was halted by labor unrest.

The Government of Jamaica and the Government of Venezuela formed a joint venture to explore the possibility of establishing a second cement plant in Jamaica. A 660,000-ton-per-year operation was envisioned, and would be geared to handle the shortages in local production, with some exports to other Caribbean countries.[35]

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[32] Page 102 of work cited in footnote 6.
Work cited in footnote 9.
Page 82 of second work cited in footnote 11.

[33] Industrial Minerals. No. 94, July 1975, p. 11.
U.S. Embassy, Dublin, Ireland. State Department Airgram A-033, May 21, 1976, p. 3.
Page 97 of work cited in footnote 6.
Page 84 of second work cited in footnote 11.

[34] World Mining. V. 28, No. 6, June 1975, p. 57.
Work cited in footnote 7.

[35] U.S. Embassy, Kingston, Jamaica. State Department Airgram A-168, Sept. 4, 1975, p. 1.
———. State Department Airgram A-226, Dec. 22, 1975, p. 1.
Pages 104 and 106 of work cited in footnote 6.
Page 83 of second work cited in footnote 11.

Japan.—Production of cement in Japan in 1975 was 72.2 million tons, a 10.4% decrease from 1974, but for the first time outproduced the United States (by 3.6%). Plant expansions comprising four large kilns with a total capacity of 4.1 million tons per year, coupled with improvements in existing capacities, increased the total cement production capacity of Japan to 122.6 million tons per year. The utilization of capacity was only 58.9% in 1975, compared with 69.2% in North America and 75.2% in total EEC member countries. Japanese exports of cement in 1975 totaled 4.5 million tons.

Aso Cement Co. placed an order with F. L. Smidth & Co. for expansion of its Tagawa plant. Equipment included a 15-½- by 246-foot, 4,400-ton-per-day rotary kiln, with twin cyclone preheaters and a precalciner in one of its strings. It was scheduled for full operation by early 1977.

Mitsui Cement Co. of Tokyo revealed a $33 million plan to significantly increase the capacity of its Tagawa plant in Fukuoka Prefecture. When the expansion is completed in 1976, production capacity will be increased 60% to 4.1 million tons annually.

Nihon Cement Co. withdrew its plan to acquire a controlling interest in Ryukyu Cement Co. of Naha, Okinawa, because the Japanese Fair Trade Commission ruled that it was monopolistic. Nihon had previously signed a contract with Kaiser Cement & Gypsum Corp. to purchase Kaiser's holdings for $9 million.[36]

Jordan.—The Jordan Cement Co. signed an agreement with Polysius A.G. to establish a cement plant with a 2,200-ton-per-day capacity. Equipment included a 15- by 246-foot rotary kiln with a cyclone preheater, an air-swept raw mill, a finish mill, two air separators, a homogenizing system, and a pneumatic conveyor system.[37]

Korea, Republic of.—In 1975, the Republic of Korea produced 11.2 million tons of cement, a 15% increase compared with 1974. The average price of cement in 1975 was 15,000 won ($30.92) per short ton. The cement industry in Korea is privately operated, but government backed as part of the economic development program. By 1977, total production is expected to reach 25 million tons annually, with 14 million tons used domestically, 7.7 million tons exported, and a reserve of 3.3 million tons.

Tongyang Cement Manufacturing Co. of Seoul started an expansion project at its Samchok plant on the northeast coast of Korea. The Fuller Co. supplied two 16- by 245-foot rotary kilns with four-stage twin Fuller preheaters, two 13- by 45-foot raw mills, three 13- by 45-foot finish mills, 10- by 70-foot rotary dryers, a 48- by 60-inch jaw crusher, and a 42-inch gyratory crusher.

The Ssangyong Cement Industries Ltd., Seoul, awarded a European consortium a contract for expanding the capacity of its Tonghae works, near Pukpyong-ni on the northeast coast of Korea, by 6.2 million tons of cement annually. This was the largest plant of its kind in the world. The order comprised planning and delivery of plant and equipment in the total amount of $125 million, with an option on a further expansion phase valued at $65 million. Overall management of the contract rested with the French consultants, Polysius S.A. of Rueil-Malmaison, France.[38]

Kuwait.—Founded in 1968, the Kuwait Cement Co. was the largest producer of cement in the country in 1975. Annual capacity of the Shuaiba plant was 330,000 tons. Iraqi clinker and gypsum were imported for the production of three types of ordinary and sulfur-resistant cement. Kuwait construction activities increased significantly during 1975, and the export and reexport of cement were banned late in the year.

A Japanese team of Onoda Cement Co. and Mitsui & Co. Ltd. was reportedly outbidding British, Spanish, and other groups in an international tender for 330,000 tons of cement clinker placed by the Kuwait Cement Co. for delivery over a 1-year period starting in March 1976. It was also reported that tenders were out for some 22,000 tons of bagged cement to be delivered on a 2-year contract.[39]

Lebanon.—Lebanon's economic situation seriously worsened since April 1975 as the result of the continuing political struggles and the civil war. Building and con-

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[36] Page 99 of work cited in footnote 6.
Work cited in footnote 7.
Page 82 of second work cited in footnote 11.

[37] Page 102 of work cited in footnote 6.

[38] U.S. Embassy, Seoul, Republic of Korea. State Department Airgram A-56, Apr. 28, 1976, p. 2.
Page 100 of work cited in footnote 6.
Page 82 of second work cited in footnote 11.

[39] U.S. Embassy, Kuwait, Kuwait. State Department Airgram A-29, Mar. 17, 1976, p. 17.
Pages 102–103 of work cited in footnote 6.

struction activities suffered from the warlike conditions. It was somewhat surprising that cement consumption in Lebanon during 1975 dropped only 16% to slightly over 1 million tons, and an additional 410,000 tons was exported. Sales of cement fell sharply during the last quarter of 1975, and production was temporarily suspended.

The Lebanese White Cement Co. placed a $5.4 million order with Buhler-Miag of West Germany for expansion equipment for the Chekka plant. Equipment consisted of a 350-ton-per-day rotary kiln for production of white cement and additional capacity in raw and finishing mill processing. The new extension was expected to be onstream by October 1976.[40]

Libya.—Humboldt Wedag was awarded an order for two 1,650-ton-per-day rotary kilns and preheater systems to be installed in a cement plant at Hawari, a suburb of Benghazi. The turnkey plant was to be supplied and erected by KHD Industrieanlagen A.G. of West Germany.[41]

Mexico.—Cement production in Mexico was 12.8 million tons in 1975, an increase of 9.6% compared with 1974. After an initial downturn in the first half of 1975, construction activity improved, and according to the economic forecast of the Banco Nacional de Mexico, building materials could expect a growth rate of 12%. Inflation amounted to 10% on an annual basis.

Cement Apasco S.A. of Mexico City commissioned in August 1975 a new production line of 2,800 tons per day of clinker, which raised the total plant capacity to 1.5 million tons per year. During the year, Cementos Veracruz S.A., in which Cementos Apasco holds a majority interest, commissioned a new production line in its Orizaba plant with a capacity of 1,320 tons per day.

Cementos Hidalgo, SCL, was expanding its Hidalgo plant in 1975. F. L. Smidth & Co. supplied a 1,650-horsepower raw mill, a 1,500-horsepower finish mill, and a rotary packer.

La Cruz Azul SCL scheduled its newly expanded Hidalgo plant for full operation in 1976. The Fuller Co. supplied a 17- by 270-foot rotary kiln with a four-stage twin preheater, a clinker cooler, and pneumatic conveying and blending equipment.

Cementos de Chihuahua completed an expansion program and commissioned the plant in late 1975. The Fuller Co. supplied a 13- by 39-foot finish mill.[42]

Morocco.—The Société Nationale d'Investissement (SNI) planned the construction of a new 440,000-ton-per-year cement plant near Marrakech. It is the first operation promoted and financed by SNI.

Another new cement company, Cimenterie Maghrebine initiated construction of a 1.1-million-ton-per-year facility at Oujda, near the Algerian border. The company is a joint venture between the Moroccan and Algerian Governments. The Consultancy Services Div. of The Associated Portland Cement Manufacturers Ltd., Blue Circle Group, will be responsible for the design, engineering, and supervision of construction of the plant, together with training of Moroccan personnel to man it. Polysius A.G. was awarded the order to provide two cyclone preheater kilns, 31 feet in diameter by 351 feet long with planetary coolers, rated at 2,000 tons per day each, two airswept raw mills, two cement mills, air separators, and homogenizing and conveying equipment.[43]

Mozambique.—It is estimated that only 300,000 tons of cement were produced in Mozambique, decreasing 55% compared with the alltime high of 674,000 tons in 1973. Companhia de Cimentos de Moçambique has three plants at Maputo (Matola), Beira (Dondo), and Nacala, with an estimated total annual capacity of 1 million tons. An almost complete paralysis in housing construction, the flight of most of the European technicians, lack of logistic support, and decrease in productivity accounted for the poor showing in 1975.[44]

Nepal.—The Himal Cement Co. made available its first consignment of 1,000 bags of cement to National Trading Ltd., its sole distributor, for marketing. The price of the Nepalese cement was fixed at NRs.45.00 ($3.60) per 94-pound bag.[45]

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[40] Page 103 of work cited in footnote 6.
Work cited in footnote 8.
Page 82 of second work cited in footnote 11.
[41] Page 101 of work cited in footnote 6.
[42] Page 106 of work cited in footnote 6.
Work cited in footnote 8.
Page 83 of second work cited in footnote 11.
[43] Page 101 of work cited in footnote 6.
Work cited in footnote 9.
Page 83 of second work cited in footnote 11.
[44] U.S. Consulate, Lourenço Marques, Mozambique. State Department Airgram A-125, Oct. 3, 1975, pp. 1–2.
[45] U.S. Embassy, Kathmandu, Nepal. State Department Airgram A-56, July 7, 1975, p. 3.

Netherlands.—The Netherlands economy suffered a considerable setback during 1975 with an estimated falloff of 2% in the real gross national product (GNP). Inflation remained at a high level of 10.5%. The construction sector was in a state of malaise, and total Dutch cement consumption was 6.1 million tons in 1975, a decrease of 5.6% compared with that of 1974.[46]

New Zealand.—New Zealand's economy was marked by stagnation in 1975, with the GNP falling by 3.5% in real value. Housing permits fell by 11%, and cement consumption drifted down 3% to 1.2 million tons for the year.

The new third kiln of the Westport plant of New Zealand Cement Holdings, Ltd., was commissioned in July 1975 according to plan, while the whole expansion program is expected to be completed in the first quarter of 1976.[47]

Nicaragua.—Production of cement in Nicaragua was 213,000 tons in 1975, an 18.1% decline from the record year of 1974. Utilization of capacity was 72%. The peak of the reconstruction of Managua from the devastating earthquake of 1972 was apparently reached in 1974, and the present unused cement plant capacity remains to be absorbed with the economic development of the country.[48]

Nigeria.—The Associated Portland Cement Manufacturers Ltd. (Blue Circle Group) participated as management partners in a northeastern Nigerian cement plant project known as Ashaka Cement, which was scheduled to go onstream by the end of 1977. Polysius A.G. supplied the turnkey plant with two GEPOL kiln lines with a rated capacity of 330,000 tons per year each. The actual site was at Ashaka on the Gongola River and was the first cement plant in the northeastern section. It was expected to play a significant role in the economic development of the region.

F. L. Smidth & Co. has been awarded a contract (under a Blue Circle management contract) to supply a new two-kiln cement plant at Shagamu, about 40 miles northeast of Lagos. Major equipment included two 1,100-ton-per-day rotary kilns, 15 feet in diameter by 500 feet in length, with coolers and electrofilters, and two 3,000-horsepower finishing mills, 12-1/2 feet in diameter by 38 feet long.

Nigeria also received special world attention in 1975. The 5-year plan of the oil-rich country somehow led to the contracting of some 23 million tons of cement worth $1 billion—about 10 times the total amount that the country's ports could handle in a year. The result was that over 400 ships, 250 of them carrying cement, lay at anchor outside the Lagos harbor. Amid legal actions, high demurrage costs, and deteriorating cement, a special tribunal was set up by the Nigerian Government, and the request was made to halt any further shipments. At best, Lagos port of Apapa was not expected to be unscrambled for a year.[49]

Norway.—Norway's largest producer of limestone and its sole producer of portland cement is A/S Norcem of Oslo, established in 1968 by a merger of three companies. Present total output of the three plants is between 5.0 and 5.5 million tons of limestone annually and 3.0 million tons of cement.

In 1975, Norwegian cement production increased by 169,000 tons to 3.1 million tons, the largest annual output ever achieved. Cement sales in Norway totaled 1.9 million tons, and exports, mainly to West Africa and the United States, totaled 1.1 million tons.[50]

Pakistan.—The State Cement Corp. planned to increase cement production in Pakistan by 1.65 million tons annually, scheduled for completion in about 3-1/2 years. Projects also started on the expansion of production in the Javedan and Mustehkam cement plants by an additional 330,000 tons per year each. Further plans called for the installation of cement plants at Spintungi near Sibi in Baluchistan, at Gadani in the Lasbela district, and at Kohat in the North-West Frontier Province. Exports were prohibited because of the increased domestic demand.

The State Cement Corp. awarded a contract to the Fuller Co. for a new 1,100-ton-per-day plant in Karachi.[51]

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[46] Works cited in footnotes 7 and 8.
[47] Work cited in footnote 8.
[48] U.S. Embassy, Managua, Nicaragua. State Department Airgram A-35, May 21, 1976, p. 1.
[49] Blue Circle Group (London, England). Annual Report, 1975, p. 8.
Page 101 of work cited in footnote 6.
Work cited in footnote 9.
Page 86 of second work cited in footnote 11.
[50] A/S Norcem. Annual Report, 1975.
Industrial Minerals. No. 88, January 1975, pp. 19–46.
[51] Page 99 of work cited in footnote 6.
Page 82 of second work cited in footnote 11.

Panama.—Empresa Estatal de Cemento Bayano awarded a $60 million contract to F. L. Smidth & Co. for the construction, on a turnkey basis, of a new 1,100-ton-per-day cement plant near Calzada Larga, north of Panama City. Equipment included a 13-½- by 191-foot rotary kiln with a four-stage suspension preheater and planetary cooler, a 770-ton-per-day crusher, a roller mill, a 14- by 40-foot finish mill, and two digital computer systems for control, suspension, and reporting of plant operations.[52]

Peru.—Compensation negotiations continued during the year concerning the nationalization of Cementos Lima S.A. in 1974. Some progress was made, and it was anticipated that the negotiations will not be concluded before mid-1976.

Cementos Lima S.A. initiated work on doubling the capacity of its Atacongo plant to 6,600 tons per day. Completed by Holderbank in 1969, the expanded plant was expected to be operational by the end of 1978. New equipment included a 6,000-horsepower raw mill, a 6,000-horsepower cement mill, and a precalcining kiln which would be the first such unit installed in the Americas.

Cementos Norte Pacasmayo planned an $18 million expansion project to increase the capacity of its plant to 2,400 tons per day of cement. The Fuller Co. and General Electric Co. were supplying equipment, including a 13-½- by 190-foot rotary kiln with suspension preheater, a 13- by 45-foot raw mill, a 12- by 45-foot finish mill, blending and conveying equipment, and four dust collector units.[53]

Philippines.—The economic development of the Philippines continued at a high level in 1975; real GNP rose by 5.9%. The upswing in the construction industry was a notable feature; private construction benefited from good demand with an 11% increase, and public construction boomed with a 22% increase. Philippine cement consumption increased 24% to 3.9 million tons. Exports rose 5% to 900,000 tons.

Société Fives-Cail Babcock obtained a contract, on a turnkey basis, for the design, fabrication, and installation of a cement plant with a capacity of 1,880 tons per day, located at Balingbing, Rizal, Philippines.[54]

Portugal.—Cement production in Portugal was 3.7 million tons in 1975, an increase of 9% compared with 1974. Cement production capacity was 5.1 million tons per year at the end of 1975, indicating a 73% utilization of capacity for 1975.

In mid-1975 the Portuguese Government continued its nationalization programs with the taking over of the country's cement industry. A national cement company, known as Cimpor-Cimentos Poruguese, may be the result of this takeover.

Secil-Companhia Geral de Cal e Cimento was expanding its cement plant production at Setubal with a $48 million project.[55]

Qatar—The Qatar National Cement Co. placed at $7 million order with Buhler-Miag of West Germany for a new rotary kiln for the company's Umm-Bab plant near the capital of Doha. The kiln measured 11-½ feet in diameter by 344 feet in length, and will have a capacity of 385 tons per day of clinker. Other equipment in the contract included a raw mill handling plant and clinker conveyors.[56]

Saudi Arabia.—Saudi Arabia's new 5-year development plan for 1975–80 called for a substantial expansion of its port facilities to handle some 14 million tons of cargo per year, and an increase in the country's cement production from the current 1.2 million tons per year to 11 million tons.

The Saudi Cement Co. at Dammam expanded its Hoffuf cement plant in eastern Saudi Arabia with a new 1.1-million-ton-per-year expansion and modernization. Two complete dry-process lines with a capacity of 550,000 tons per year each were awarded to Polysius A.G. at a total turnkey contract cost of $85 million. Modernization of the existing three kilns, originally installed by Polysius between 1959 and 1968, was also completed, including electrostatic precipitators, power stations, and a process automation system. This order represented the largest order ever given to Polysius A.G.

Yanbu Cement Co. of Saudi Arabia awarded a feasibility study to Naigai Consultant Co. of Tokyo for the construction

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[52] Page 106 of work cited in footnote 6.
Page 83 of second work cited in footnote 11.
[53] Page 106 of work cited in footnote 6.
Work cited in footnote 8.
Page 84 of second work cited in footnote 11.
[54] Work cited in footnote 8.
Page 82 of second work cited in footnote 11.
[55] Page 97 of work cited in footnote 6.
Work cited in footnote 7.
Page 84 of second work cited in footnote 11.
[56] Page 103 of work cited in footnote 6.

of two cement plants with a total production capacity of 1,650 tons per day in the Yanbu area on the Red Sea.

A French company won an initial contract for the construction of a cement plant at Buraydah with a capacity of 2,200 tons per day. It is expected to be onstream in 3 years. French experts also made studies on a 2,200-ton-per-day plant at nearby Qasim.[57]

Somalia.—In October 1975, ground was broken for a $12 million, 110,000-ton-per-year cement plant at Suryo Malable, southeast of Berbera. The project, jointly financed between the North Korean and the Somali Governments, is to begin operation in mid-1977[58]

South Africa, Republic of.—The South African economy in 1975 was materially influenced by the worldwide recession. Cement consumption in 1975 declined 1.1% to 7.6 million tons compared with that of 1974. The housing sector improved toward yearend. Members of the local Cement Producers Association have stopped all plant expansion efforts until demand and price combine to permit additional investment allowances.[59]

Spain.—Cement production in 1975 increased 1% to 26.4 million tons. Total production capacity was 33 million tons. Thus, Spain achieved an 80% utilization of capacity, in spite of a 6% dropoff in domestic consumption. Exports were 3.7 million tons, more than double those of 1974, placing Spain among the world's principal exporters of cement.

During the year a new production line was erected in Spain by Polysius A.G. Equipment included a 3,300-ton-per-day DOPOL kiln with a planetary cooler.[60]

Sudan.—Two U.S. companies—Buttes Gas and Oil and KH International—initiated construction of a $40 million, 440,000-ton-per-year cement plant on the Red Sea. A Sudanese company, Cement Production (Sudan), was participating with the construction. The operation was to furnish part of Sudan's requirements and export the balance to the Middle East market.[61]

Switzerland.—Cement production in 1975 was 4.2 million tons, a 26% reduction compared with 1974. Total capacity was 7.4 million tons, indicating a utilization of only 58% of capacity for the year, mostly because of the steep decline in cement consumption in Switzerland. Only insignificant tonnages were exported.

The most modern cement plant in Switzerland, the new Rekingen-Mellikon plant of Cementfabrik Holderbank, was brought into operation in mid-1975. This dry-process plant had a production capacity of 770,000 tons per year.[62]

Syria.—The Syrian Government planned to raise annual cement production from 1.1 million tons per year in 1975 to 6.6 million tons by 1980. East Germany was building four plants—at Hamah, Tartus, Aleppo, and Adra. The expanded 7,000-ton-per-day Tartus plant was scheduled for completion in December 1978; Aleppo was due for operation in 1975; Hamah and Adra are to begin in 1976 and 1977, respectively. In midyear a further boost took place in already close Syrian-Romanian economic relations. Import-Export of Romania signed a contract in Damascus for $110 million to build the 3,300-ton-per-day cement plant at Aleppo.[63]

Taiwan.—The Tang Eng Iron Works was constructing a new cement plant with a capacity of 660,000 tons per year at a cost of $26 million. Completion was scheduled for mid-1976. The plant is located near Ilan in northeastern Taiwan, and a portion of the output will be exported.

An expansion project of the Cheng Tai Cement Co. in Taipei was initiated and was scheduled for full operation early in 1976. The Fuller Co. supplied a 13-½- by 195-foot rotary kiln with a four-stage preheater, a Fuller-Loesche roller mill, and a 12- by 38-½-foot finish mill.

The Fuller Co. also completed another capacity expansion at the Chia Hsin Cement Corp. They supplied the major equipment including a 15- by 220-foot rotary kiln with a four-stage preheater, two Fuller-Loesche roller mills, and an 11- by 32-foot finish mill.

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[57] Page 103 of work cited in footnote 6.
Work cited in footnote 9.
Page 82 of second work cited in footnote 11.
[58] U.S. Bureau of Mines. Cement: Somalia. Mineral Trade Notes, v. 73, No. 1, January 1976, p. 4.
[59] U.S. Embassy, Johannesburg, South Africa. State Department Airgram A-65, Aug. 18, 1976, pp. 69–73.
Work cited in footnote 8.
[60] U.S. Embassy, Madrid, Spain. State Department Airgram A-77, Apr. 21, 1976, p. 5.
Works cited in footnotes 7 and 9.
[61] Page 103 of work cited in footnote 6.
Page 83 of second work cited in footnote 11.
[62] Works cited in footnotes 7 and 8.
[63] Page 103 work cited in footnote 6.

The Kuan Hsi Cement Corp. started the construction of a new cement plant at Kaohsiung, with a capacity of 1.3 million tons per year at a cost of $40 million. Government enterprises were responsible for construction, and installation of machinery was handled by the Tang Eng Iron Works.

The new 2,600-ton-per-day dry-process cement plant of the China Rebar Co., Ltd., at Tungsha was under construction and scheduled for completion by mid-1976. Allis-Chalmers furnished all the major equipment, including a 16- by 230-foot rotary kiln with suspension preheater, a 1,750-horsepower roller mill rated at 198 tons per hour, a 550-horsepower finish-grinding mill, 14 feet in diameter by 46 feet in length, rated at 116 tons per hour, and other accessory equipment.[64]

Thailand.—The International Finance Corp., an affiliate of the World Bank, lent $10 million to help finance a $62 million expansion program for the four companies in the Siam Cement Group. Siam Cement Co. Ltd.'s portion of the plan called for an additional 880,000 tons per year of cement capacity, two cement distribution centers at Bangkok, and facilities for loading clinker on oceangoing vessels. The increase in cement output was to meet the growing demand and to take advantage of the export market in the area.[65]

Togo.—The Government of Togo planned to double Ciments du Togo's cement plant capacity to 275,000 tons per year. In mid-1975, all export licenses were canceled in an attempt to alleviate domestic shortages caused by the foreign demand for much of Togo's 140,000-ton annual cement output.

Blue Circle Group's consultancy services signed an agreement with Les Ciments de l'Afrique de l'Ouest (CIMAO), a Togo company, to provide engineering services for a new cement industry. CIMAO was a joint venture between the Governments of Togo, the Ivory Coast, and Ghana, and was set up to provide an integrated cement industry for the three countries. CIMAO proposed to build a 1.3-million-ton-per-year clinker plant in the area of Tabligbo, 36 miles northeast of Lomé, the capital of Togo. The clinker would be shipped from the plant to Lomé, both for grinding into cement for Togolese use and for shipment to Ghana and the Ivory Coast. The plant would be a two-kiln dry-process operation, and was planned to come onstream in 1979.[66]

Trinidad and Tobago.—The Government of Trinidad and Tobago proposed the construction of a new 330,000-ton-per-year cement plant rather than expanding the existing 300,000-ton-per-year facility of Trinidad Cement Ltd. A technical appraisal of the present plant will be completed before implementation of the new plans. If the appraisal is favorable, startup is scheduled for 1978.[67]

Turkey.—Cement production in Turkey was 11.8 million tons in 1975, a 4.9% increase compared with that of 1974. Cement production capacity also increased to 16.1 million tons annually, indicating a 74% utilization of capacity for the year. Increase in production capacity for 1975 included 2.8 million tons per year in new kilns and 800,000 tons per year in improvement of existing capacities. Total exports of cement were 980,000 tons, mainly to Bulgaria, Syria, Iran, and neighboring Middle East countries.

Construction of a 550,000-ton-per-year cement plant was initiated at Yozgat, Central Anatolia. Financing for the plant was arranged through a $7.7 million loan from the European Investment Bank. Approval of the loan was in support of a plan through which Turkish workers in Western Europe were able to invest their savings in the industrial development of their own country. The plant was established by Yozgat Isçi Birligi Insaat Malzemeleri ve Sanayi, a joint stock company formed in 1973. Lignite mined in Turkey will be used as fuel.

The Darica plant of Aslan ve Eskihisar Müttehit Çimento ve Su Kireci Fabrikasi A.Ş. initiated a project to double its cement production capacity to 1.1 million tons per year by 1977. The total project will cost $31 million, of which the International Finance Corp. lent $10.6 million to support the project.

The Turkish Economic Press Agency reported that the $27 million cement plant

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[64] Page 100 of work cited in footnote 6.
Page 82 of second work cited in footnote 11.
Page 51 of second work cited in footnote 31.
[65] Page 100 of work cited in footnote 6.
[66] U.S. Embassy, Lomé, Togo. State Department Airgram A-43, Aug. 19, 1975, p. 1.
Page 101 of work cited in footnote 6.
[67] U.S. Embassy, Port-of-Spain, Trinidad and Tobago. State Department Airgram A-49, June 1, 1976, pp. 8-9.

of the state-owned Türkiye Çimento Sanayii T.A.Ş, located in Mersin, was inaugurated in midyear. The plant capacity is 1.5 million tons per year.[68]

U.S.S.R.—The Soviet Union is the largest producer of cement in the world, with an estimated production of 134 million tons in 1975, a 6% increase compared with 1974. About 1965, the U.S.S.R. surpassed the United States in cement production, and it has had an indicated growth rate of 3.2% for the last 15 years. During this same period, U.S. portland cement production had an indicated growth rate of only 1.2%.

In 1975, the Moscow Research Institute established a CEMBUREAU-type organization for the countries belonging to the Council for Mutual Economic Assistance (CMEA). The new organization, known as the Cement Industries' International Coordination Center, will coordinate all research carried out in the CMEA countries, with joint activities planned in some 30 research topics. A central objective of the effort was the development of dry-process cement manufacture.[69]

United Arab Emirates.—The Société Fives-Cail Babcock was given contracts for a 770-ton-per-day cement plant for the Emirate of Sharja at the new industrial city, and a 660-ton-per-day cement plant for the Emirate of Abu Dhabi.[70]

United Kingdom.—Production of cement in the United Kingdom was 18.6 million tons in 1975, a 5.0% decrease compared with that of 1974. At the end of 1975, cement production capacity was 24.7 million tons annually, which indicated a 75% utilization of cement production capacity. Exports were 770,000 tons for the year, and domestic consumption was down 4% compared with 1974. The closing of one plant and the mothballing of kilns at six other plants effectively reduced available capacity by over 2.2 million tons per year.

In Wales, an expansion project for the Aberthaw plant of Aberthaw and Bristol Channel Portland Cement Co. near Barry, South Glamorgan, was completed. The new production line consisted of a kiln and preheater, raw material grinding plant, and precipitator plant. The new kiln was stated to be one of the most advanced in the United Kingdom, capable of producing at least 1,500 tons of clinker per day, and boosted total output of the plant to 3,100 tons per day.[71]

Upper Volta.—Plans were implemented to construct a cement plant with a capacity of 80,000 to 100,000 tons per year at Tin Hrassan.[72]

Venezuela.—Venezuela produced 3.8 million tons of cement in 1975, a 1.1% decrease compared with that of 1974. Cement shortages led to increased imports from Puerto Rico.

Holderbank Consulting Ltd., Mississauga, Ontario, Canada, was awarded a contract by Cementos Caribe S.A. of Caracas for engineering and project management for a new, 3,300-ton-per-day cement plant at Puerto Cumarebo, near Coro. The dry-process plant will consist of a preblending system, a fuel-economizing preheater rotary kiln with partial precalcining, process automation, and a marine distribution system. Construction will be initiated in 1976, and production is scheduled for 1978.

C. A. Venezolana de Cementos had two expansion programs underway with F. L. Smidth & Co. At the Pertigalete plant, a new 12- by 13-½- by 472-foot Unax rotary kiln, with a 3.1-million-ton-per-year capacity was being installed. At Maracaibo, F. L. Smidth & Co. also supplied a 12- by 450-foot rotary kiln with a 410,000-ton-per-year capacity.[73]

Yemen Arab Republic.—The new 220,000-ton-per-year wet-process cement plant built by the Soviets at Bajil, some 30 miles from the southwest Yemen Red Sea coastal port of Hodeida, was in operation. The U.S.S.R. supplied the equipment and trained the Yemenese staff in the Soviet Union.[74]

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[68] Page 47 of work cited in footnote 4.
Page 98 of work cited in footnote 6.
Work cited in footnote 7.
Page 83 of second work cited in footnote 11.
[69] Page 98 of work cited in footnote 6.
[70] U.S. Embassy, Abu Dhabi, United Arab Emirates. State Department Airgram A-25, May 6, 1975, p. 2.
Page 83 of second work cited in footnote 11.
[71] Page 98 of work cited in footnote 6.
Page 6 of first work cited in footnote 49.
[72] U.S. Embassy, Ouagadougou, Upper Volta. State Department Airgram A-21, Apr. 22, 1975, p. 4.
[73] U.S. Embassy, Caracas, Venezuela. State Department Airgram A-59, May 18, 1976, p. 2.
Page 106 of work cited in footnote 6.
[74] Page 103 of work cited in footnote 17.

Table 21.—Hydraulic cement: World production, by country

(Thousand short tons)

Country	1973	1974	1975 p
North America:			
Bahamas	1,051	875	510
Canada (sold or used by producers)	11,126	11,436	10,763
Costa Rica	300	328	364
Cuba e	1,650	1,650	1,650
Dominican Republic	r 640	667	647
El Salvador	265	326	366
Guatemala	342	342	435
Haiti	119	157	170
Honduras	259	237	299
Jamaica	444	440	448
Mexico	10,788	11,679	12,800
Nicaragua	212	260	213
Panama	478	435	305
Trinidad and Tobago	r 279	267	285
United States (including Puerto Rico)	87,573	82,888	69,722
South America:			
Argentina	5,711	5,944	5,932
Bolivia	184	223	249
Brazil	14,769	16,446	18,400
Chile	r 1,512	1,569	1,034
Colombia	r 3,551	3,783	3,407
Ecuador	535	551	551
Paraguay	r 82	114	169
Peru	r 2,601	1,908	e 1,980
Surinam	68	50	e 55
Uruguay	570	603	702
Venezuela	3,762	3,851	3,808
Europe:			
Albania	571	e r 570	e 570
Austria	6,900	7,093	6,206
Belgium	7,761	8,232	7,588
Bulgaria	4,605	4,738	4,802
Czechoslovakia	9,238	9,884	10,251
Denmark	3,183	2,747	2,466
Finland	r 2,306	2,428	2,274
France	33,855	35,791	32,241
Germany, East	10,525	11,125	11,746
Germany, West	45,208	39,658	36,945
Greece	7,158	7,751	8,677
Hungary	r 3,753	3,789	4,144
Iceland	148	171	175
Ireland	r 1,733	1,840	1,721
Italy	40,027	40,024	37,738
Luxembourg	394	431	378
Netherlands	4,494	4,506	4,085
Norway	r 3,005	2,908	3,077
Poland	17,139	18,480	20,450
Portugal [1]	3,639	3,632	3,664
Romania	10,856	12,340	13,200
Spain (including Canary Islands)	r 24,656	26,085	26,429
Sweden	4,645	3,648	3,440
Switzerland	6,345	5,794	4,150
U.S.S.R	120,703	126,766	134,482
United Kingdom	22,031	19,600	18,625
Yugoslavia	7,028	7,327	7,788
Africa:			
Algeria	r 1,110	1,037	e 1,000
Angola	847	838	770
Cameroon	212	222	262
Cape Verde Islands	13	4	e 4
Egypt	3,987	3,598	3,945
Ethiopia	r 137	127	160
Ghana	481	e 500	e 500
Ivory Coast	733	694	e 700
Kenya	873	944	965
Liberia	98	95	e 100
Libya	87	551	678
Malagasy Republic	77	67	64
Malawi	r 98	90	120
Mali	52	e 50	e 50
Morocco	1,785	1,927	2,235
Mozambique	674	513	e 300
Niger	80	23	20
Nigeria	1,347	1,323	1,504
Rhodesia, Southern	742	831	741
Senegal	326	366	396

See footnotes at end of table.

Table 21.—Hydraulic cement: World production, by country—Continued

(Thousand short tons)

Country	1973	1974	1975 p
Africa—Continued			
South Africa, Republic of	7,566	8,048	e 7,900
Sudan	229	331	154
Tanzania	346	326	293
Togo	126	141	165
Tunisia	r 578	595	679
Uganda	158	169	e 165
Zaire	592	636	e 660
Zambia	454	e 420	e 420
Asia:			
Afghanistan 2	155	161	154
Bangladesh	r 33	96	103
Burma	r 209	186	224
China, People's Republic of e	27,560	27,560	33,100
Cyprus	497	373	685
Hong Kong	486	629	634
India	16,541	15,722	17,895
Indonesia	805	916	971
Iran	3,846	e 4,300	e 4,300
Iraq e	2,000	2,000	2,000
Israel	1,387	1,980	2,413
Japan	86,110	80,588	72,222
Jordan	680	657	631
Khmer Republic	86	e 55	e 55
Korea, North e	6,400	6,600	6,600
Korea, Republic of	9,011	9,747	11,165
Lebanon	1,829	1,922	e 1,100
Malaysia	1,409	1,504	e 1,570
Mongolia	161	188	e 190
Pakistan	3,169	3,801	3,379
Philippines	4,474	3,861	3,982
Qatar e	110	110	110
Saudi Arabia	r 1,063	1,125	e 1,200
Singapore	1,133	e r 1,200	e 1,200
Sri Lanka	r 465	522	432
Syria	935	1,064	e 1,100
Taiwan	6,720	6,802	7,491
Thailand	4,085	4,324	4,392
Turkey	r 9,861	11,281	11,839
Vietnam, North e	550	660	700
Vietnam, South	292	e 110	e 55
Yemen	13	40	e 55
Oceania:			
Australia	5,784	5,738	5,530
Fiji Islands	101	94	80
New Caledonia	58	73	e 80
New Zealand	1,166	1,224	1,184
Total	r 773,769	776,066	766,347

e Estimate. p Preliminary. r Revised.

1 Includes production from the Azores and Madeira Islands as follows, in thousand short tons: 1973—Azores 22, Madeira 35; 1974—Azores 15, Madeira 34; 1975—not available. The balance of output in each year was from continental Portugal.

2 Year beginning March 21 of that stated.

TECHNOLOGY

A new cement production process developed in Japan has been licensed to a French engineering company under a recently signed agreement. Developed by Kawasaki Heavy Industries Ltd. and Onoda Cement Co. and licensed to Cruesot-Loire Enterprises, the process involved a reinforced suspension preheater (RSP) for dry-process operation, which it was claimed made possible the production of cement at rates three times those of conventional suspension preheaters. At the same time, it was said that the RSP process also reduced harmful atmospheric emissions during cement production.

In the new process, a combustion furnace with a special burner is placed between the cement kiln and the suspension preheater to decarbonate approximately 90% of the raw materials before they enter the kiln. This reduces the thermal load of the kiln and increases its efficiency, enabling an improvement of the cement production rate. Onoda Cement Co. made a full-scale application of the process in 1972 and in 1974 completed a 3,000-ton-per-day plant at its Ofunato works adaptable to the RSP process. Kawasaki was responsible for development of the RSP hardware. At a 2,700-ton-per-day production rate with the RSP process, specific kiln loading was measured at 10.2 pounds of clinker per cubic foot of kiln shell volume per hour. The developers see a possibility of producing 4,000 tons per day in a 14.8-foot-diameter kiln and more than 7,000 tons per day in a 18-foot-diameter kiln. The process is considered applicable both to existing suspension preheater kilns by modification and to new installations.[75]

In 1975, Brown Boveri & Cie., Baden, West Germany, installed the first gearless cement mill drive in Switzerland. The installation took place at Holderbank's new 770,000-ton-per-year Rekingen Aagau cement plant. The gearless drive had a rating of 5,200 kilowatts. In recent years in Central Europe, and especially in West Germany, the use of gearless drives for tube mills in the cement industry has gained increasing acceptance.[76]

At the Brevik plant of A/S Norcem, Norway, a new system was installed in 1975 for feeding the pelletized feed into the grate of the furnace. Rather than an ordinary chute feed, a Sala reciprocating conveyor was used, which handled the pellets gently and spread them in an even layer over the grate without crushing. In the first month after installation, capacity increased by 23%, with a reduction in oil consumption of 13%.[77]

A survey and comparison of U.S. cement plant operating developments indicated the direction the future may take. It is summarized as follows:

1. It will be impossible to replace all of the present wet capacities with dry plants in the foreseeable future. Therefore, the thermal efficiency improvement of present systems will be most imperative.

2. Fewer conversions of existing plants from wet to dry than originally anticipated will actually be undertaken, because the return-on-investment will be very marginal.

3. In all new plants, the concept of larger single-kiln plants will have to be adopted.

4. The trend to large single-kiln plants will further reduce manpower requirements and will give significant improvements in fuel and power savings.[78]

In 1975, the Japanese firm of Ishikawajima-Harima Heavy Industries, Ltd. claimed that the new SF sintering process set record figures in both throughput and heat requirements for cement clinker burning. In addition, the lifespan of the kiln brick was greatly prolonged owing to the reduction in heat load at the kiln's sintering zone.

Also announced by Ishikawajima-Harima in 1975 was the development of a new, highly efficient electrostatic precipitator. Called the EP-ES type, after exhaustive testing it was proved that the exist dust concentration could be reduced to less than 0.03 grams per normal cubic meter under full operating conditions. The precipitating capacity was extremely stable compared with the conventional type, while working under wide fluctuations of dust concentration, gas flow rate, and gas temperature at the inlet.[79]

[75] Mining Congress Journal. V. 61, No. 11, November 1975, p. 16.
[76] Page 98 of work cited in footnote 6.
[77] Quarry Management and Products (Nottingham, England). Feeding a Norwegian Cement Kiln. V. 2, No. 2, February 1975, p. 51.
[78] Schroth, G. A. and T. K. Diener (Polysius Corp., Atlanta). Trends in the U.S. Cement Industry. Rock Products, v. 79, No. 2, February 1976, pp. 60–62, 64.
[79] Cement Technology (London). IHI Plant Boosts Japanese Cement Production. V. 6, No. 1, January/February 1975, p. 27.

Chromium

By John L. Morning [1]

Domestic demand for chromium in 1975 dropped to about the same level as that of 1971 after establishing a record high in 1974. Although there were no sales of government chromite stockpile excesses, delivery of chromite from prior year contract sales totaled nearly 418,000 tons, some of which was exported. Despite reduced demand for chromium in 1975, imports of ferrochromium established a record high. The published price of Soviet and Turkish chromite more than doubled at the beginning of the year, but the increase was not reflected by price increases of chromium alloys.

Table 1.—Salient chromite statistics
(Thousand short tons)

	1971	1972	1973	1974	1975
United States:					
Exports	35	20	21	18	139
Reexports	145	57	34	99	45
Imports for consumption	1,299	1,056	931	1,102	1,252
Consumption	1,093	1,140	1,387	r 1,450	881
Stocks Dec. 31: Consumer	1,019	857	597	573	952
World: Production	7,093	6,725	r 7,381	r 8,187	8,741

r Revised.

Legislation and Government Programs.—Government chromium material inventories are shown in table 2. Included in the inventories is material sold but unshipped. This includes chemical-grade chromite, 120,534 tons; refractory-grade chromite, 484,797 tons; and metallurgical-grade chromite, 671,813 tons.

During the year, no chromium material was available for sale from government stockpile excesses. Congressional authorization is required for disposal of these materials.

Deliveries of material from prior-year sales contracts included the following: Chemical-grade chromite, 83,379 tons; refractory-grade chromite, 97,862 tons; metallurgical-grade chromite, 236,744 tons; and chromium metal, 199 tons.

Early in the 94th Congressional session, a bill to amend the United Nations Participation Act of 1945, to halt the importation of Rhodesian chromium (in essence repeal of the Byrd amendment of 1971), was introduced in the House of Representatives. Considerable publicity was given by both those interested in reimposing chromium sanctions on Southern Rhodesia owing to political ramifications in Africa and those that believed reimposing sanctions would be harmful to the National Security. In September, the House voted against the bill thereby terminating the issue for the balance of the year.

In January, a petition was placed with the Department of the Treasury regarding alleged remuneration granted by the South African Government for manufacture or export of ferrochromium which constituted a violation under the Tariff Act of 1930, as amended. A preliminary finding in June

[1] Physical scientist, Division of Ferrous Metals.

reported that benefits had been received by manufacturers/exporters which, under certain circumstances, constitute payment of a bounty or grant, directly or indirectly. The South African Government agreed to discontinue power rebates, concessionary rail rates, and a finance charge aid scheme while manufacturers/exporters agreed to cease claiming an income tax reduction for certain export related expenses. At yearend, Treasury in a final determination found that no bounties or grants were being paid directly or indirectly within the meaning of the Tariff Act.

The Department of the Interior conducted an economic analysis of four critical materials including chromium. Supply/demand analysis, based on supply disruptions or cartel actions, resulted in a recommendation of a stockpile size of 1.2 million tons of contained chromium in various marketable forms proportional to the U.S. historical use patterns.[2]

[2] U.S. Department of the Interior. Office of Minerals Policy Development. Critical Materials: Commodity Action Analyses Aluminum, Chromium, Platinum, and Palladium. March 1975, 278 pp.

Table 2.—U.S. Government chromium stockpile material inventories and objectives
(Thousand short tons)

	Objective	Inventory by program, Dec. 31, 1975			
		National stockpile	Defense Production Act	Supplemental stockpile	Total [1]
Chromite, chemical-grade	8	371	--	--	371
Chromite, metallurgical-grade	445	2,171	682	323	3,176
Chromite, refractory-grade	54	740	--	145	885
Ferrochromium, high-carbon	11	126	--	276	403
Ferrochromium, low-carbon	--	128	--	191	319
Ferrochromium-silicon	--	26	--	33	58
Chromium metal	--	--	--	4	4

[1] Data may not add to totals shown because of independent rounding.

PRODUCTION

Domestic mine production of chromite ceased in 1961 when the last Government Defense Production Act contract was phased out. However, the United States continued to be one of the world's leading chromite consumers in producing chromium alloys, refractories, and chemicals. The principal producers of these products were as follows:

Company	Plant
Metallurgical industry:	
Airco Alloys and Carbide Div., Air Reduction Co. Inc	Calvert City, Ky. Niagara Falls, N.Y. Charleston, S.C.
Chromium Mining & Smelting Corp	Woodstock, Tenn.
Foote Mineral Company	Keokuk, Iowa. Graham, W. Va.
Interlake, Inc	Beverly, Ohio.
Prairie Metals and Chemicals, Inc	Prairie, Miss.
Satralloy Corp	Steubenville, Ohio.
Shieldalloy Corp., Division of Metallurg Inc	Newfield, N.J.
Union Carbide Corp	Niagara Falls, N.Y. Marietta, Ohio. Alloy, W.Va.
Refractory industry:	
Basic Inc	Maple Grove, Ohio.
Corhart Refractories Co., Inc	Louisville, Ky. Pascagoula, Miss.
General Refractories Co	Baltimore, Md. Lehi, Utah.
Harbison-Walker Refractories (a division of Dresser Industries, Inc.)	Hammond, Ind. Baltimore, Md.
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif. Columbiana, Ohio. Plymouth Meeting, Pa.
North American Refractories Co	Womelsdorf, Pa.
Ohio Fire Brick Co	Jackson, Ohio.
Chemical industry:	
Allied Chemical Corp	Baltimore, Md.
Diamond Shamrock Corp	Castle Haynes, N.C.
PPG Industries, Inc	Corpus Christi, Tex.

Table 3.—Production, shipments, and stocks of chromium ferroalloys and chromium metal
(Short tons)

Alloy	Production		Shipments	Producer stocks Dec. 31
	Gross weight	Chromium content		
1974:				
Low-carbon ferrochromium	86,912	60,706	93,316	3,047
High-carbon ferrochromium	214,521	144,910	228,425	13,647
Ferrochromium-silicon	97,359	35,096	101,540	2,519
Other [1]	28,639	16,907	32,101	1,417
Total	427,431	257,619	455,382	20,630
1975:				
Low-carbon ferrochromium	53,958	37,875	46,988	14,208
High-carbon ferrochromium	117,831	78,071	118,268	47,295
Ferrochromium-silicon	52,508	19,467	41,590	12,354
Other [1]	24,296	14,380	22,426	4,999
Total	248,593	149,793	229,272	78,856

[1] Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.

CONSUMPTION AND USES

Domestic consumption of 881,000 tons of chromite ore and concentrate containing about 256,000 tons of chromium was 39% below that of 1974. Of the total chromite consumed, the metallurgical industry used 60.4%; the refractory industry, 20.8%; and the chemical industry, 18.8%. The metallurgical industry consumed 532,000 tons of chromite containing 162,000 tons of chromium in producing 248,593 tons of chromium alloys and metal. About 55.3% of the metallurgical-grade ore had a chromium-to-iron ratio of 3:1 and over, 20.4% had a ratio between 2:1 and 3:1, and 24.3% had a ratio of less than 2:1.

Producers of chromite-bearing refractories consumed 183,000 tons of ore containing about 43,000 tons of chromium. The chemical industry consumed 166,000 tons of chromite containing about 51,000 tons of chromium in producing 122,000 tons of chromium chemicals (sodium bichromate equivalent).

Chromium has a wide range of applications in the three consuming industries. In the metallurgical industry, its principal use is in stainless steel. Stainless steel accounted for 61% of all chromium alloys consumed followed by full alloy steels (21%), high-strength low-alloy and electrical steels (5%), and carbon steels (2%). Total chromium alloy consumption decreased 42% from that of 1974.

The refractory industry utilizes chromium in the form of chromite primarily for the manufacture of refractory bricks to line metallurgical furnaces. Consumption of chromite for refractory purposes decreased 38% compared with that of 1974.

The chemical industry consumes chromite for manufacturing sodium and potassium bichromite, the base material for a wide range of chromium chemicals. Chromite consumption in this industry decreased 34% compared with that of 1974.

Strong demand for chromium in 1974 brought shortages of material essential to military systems. The impact of these shortages caused delays in development and production schedules and increased costs. In order to obtain a clear picture of shortages and primary causes thereof, the Department of Defense held a workshop on material shortages in January 1975. Since the United States relies on imports for its supply, chromium was a prominent topic of discussion.[3]

Basic nonfuel material requirements to the year 1990 to achieve the objectives of Project Independence were forecast.[4] A total of 279,000 tons of chromium was projected for use in equipment for fossil fuels recovery and processing; geothermal and hydroelectric plants; uranium mining, processing, and power generation plants using nuclear energy; solar energy systems; and electric power transmission and distribu-

[3] Metals and Ceramics Information Center, Battelle Columbus Laboratories. Proceedings of the Department of Defense Material Shortage Workshop. Jan. 14–16, 1975. MCIC SR-75-01, February 1975, 356 pp.

[4] Albers, J. P., and W. J. Bawiec. Non-Fuel Minerals and Materials Needed by the United States Energy Industry, 1975–90. U.S. Geol. Survey Open File Rept. 75-583, September 1975, 112 pp.

tion. Most of the chromium requirement was for use in nuclear energy power generating facilities.

The U.S. Air Force conducted a workshop on chromium to identify and examine research and development options that might exist to conserve chromium in Air Force use. The workshop brought out that the Air Force is a low-volume user of chromium, but that use is strategically important. Most chromium usage was for aircraft engines, primarily as superalloys, and the cost of superalloys is relatively insensitive to price increases of chromium.[5]

Table 4.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States

Year	Metallurgical industry		Refractory industry		Chemical industry		Total	
	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)	Gross weight (thousand short tons)	Average Cr_2O_3 (percent)
1971	720	47.8	193	36.3	180	45.6	1,093	45.4
1972	727	47.9	224	35.9	189	45.7	1,140	45.2
1973	920	48.1	261	35.0	206	45.3	1,387	45.2
1974	r 904	47.0	r 295	35.2	251	44.8	r 1,450	r 44.2
1975	532	44.6	183	34.5	166	44.9	881	42.5

r Revised.

Table 5.—U.S. consumption and consumer stocks of chromium ferroalloys and metal, in 1975

(Short tons, gross weight)

	Low-carbon ferrochromium	High-carbon ferrochromium	Ferrochromium silicon	Other	Total
Steel:					
Carbon	922	3,692	1,081	1,313	7,008
Stainless and heat resisting	43,643	119,280	40,043	203	203,169
Full alloy	14,305	45,473	4,940	5,045	69,763
High-strength low-alloy and electric	2,473	10,196	2,563	2,285	17,517
Tool	931	2,846	115	23	3,915
Cast irons	1,266	8,342	270	657	10,535
Superalloys	3,921	6,073	532	1,857	12,383
Alloys (excluding steels and superalloys):					
Welding and alloy hard-facing rods and materials	1,099	965	W	313	2,377
Other alloys [1]	1,085	1,382	8	1,685	4,160
Miscellaneous and unspecified	3,855	825	86	119	4,885
Total	73,500	199,074	49,638	[2]13,500	335,712
Chromium content	50,732	123,722	18,541	8,404	201,399
Stocks Dec. 31, 1975	10,974	50,076	4,418	[3]2,352	67,820

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."
[1] Includes magnetic and nonferrous alloys.
[2] Includes 3,568 tons of chromium metal.
[3] Includes 874 tons of chromium metal.

STOCKS

Owing to weak chromium demand and a high level of imports in 1975, industry stocks of both chromite and chromium alloys increased substantially over those of 1974. Chromite stocks increased by 379,000 tons or 66%, while chromium alloy stocks increased 72,000 tons or 97%. Consumer chromium alloy stocks in general rose steadily throughout the year and more than tripled by yearend. Based on 1974 con-

[5] U.S. Air Force. Summary Report on Air Force Chromium Workshop. Metals and Ceramics Division, Air Force Materials Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, May 1975, 136 pp.

sumption, a strong demand year, chromite stocks in the metallurgical industry were sufficient for 9 months; for the chemical industry, nearly 5 months; and for the refractory industry, 6 months. Chromium alloys in the hands of producers and consumers totaled nearly 147,000 tons at yearend 1975, equivalent to a 3 months' supply at the 1974 consumption rate. A considerable tonnage of chromium alloys was in the hands of traders at yearend.

Stocks of chromium chemicals (sodium bichromate equivalent) at producer plants increased from 14,525 tons in 1974 to 15,205 tons in 1975.

Table 6.—Consumer stocks of chromite, December 31
(Thousand short tons)

Industry	1971	1972	1973	1974	1975
Metallurgical	667	601	339	340	701
Refractory	233	160	154	169	154
Chemical	119	96	104	64	97
Total	1,019	857	597	573	952

Table 7.—Consumer stocks of chromium ferroalloys and chromium metal, December 31
(Short tons, gross weight)

Product	1971	1972	1973	1974	1975
Low-carbon ferrochromium	10,500	10,666	15,802	14,937	10,974
High-carbon ferrochromium	9,475	12,061	24,162	25,280	50,076
Ferrochromium-silicon	3,040	3,391	6,740	10,227	4,418
Other [1]	1,382	1,304	1,752	3,303	2,352
Total	24,397	27,422	48,456	53,747	67,820

[1] Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.

PRICES

Published prices of Turkish and Soviet chromite more than doubled at the beginning of the year. The price of Soviet chromite, which was quoted at $53 to $58 per metric ton, Black Sea ports for most of 1974, was quoted at $130 to $140 per ton in January and moved higher to $150 per ton in September. Turkish chromite, quoted at $65 per long ton Turkish ports in the last quarter of 1974, increased to $132 to $142 per ton late in January where it remained for the balance of the year.

South African Transvaal chromite, which was quoted at $47 to $52 per long ton Southern African ports in the latter part of 1974, decreased to $32.50 to $37.60 per ton at the beginning of the year. In August, the price was increased to $37 to $52 per ton for the balance of the year.

Owing to slack demand and high industry stocks, little price movement was visible for chromium alloys during the year despite the large price increases for Soviet and Turkish ores. The price for both U.S. and imported charge chromium decreased while U.S. high-carbon ferrochromium remained unchanged. The price spread for U.S. low-carbon (0.05% carbon) ferrochromium was narrowed, but the price of imported low-carbon ferrochromium decreased significantly. Prices of chromium alloys as published by Metals Week follow:

Material	*Cents per pound of chromium*	
	January	*December*
U.S. charge chromium	50	45–50
U.S. high-carbon ferrochromium	54–61	54–61
Imported charge chromium	65–75	44–50
U.S. low-carbon ferrochromium (0.05% carbon)	83–120	92–120
Imported low-carbon ferrochromium (0.05% carbon)	135–145	73–83
Simplex	85	92
	Cents per pound of product	
Aluminothermic chromium metal	230	244
Electrolytic chromium metal	230	244

FOREIGN TRADE

Exports of chromite reached a record high as some chromite from sales of government stockpile excesses moved into world trade. Reexports of chromite decreased 55% compared with that of 1974. Major export shipments were to Sweden (34%), the Netherlands (26%), Mexico (16%), Japan (8%), and Canada (8%). Smaller quantities were shipped to six other countries. Reexports were shipped to Mexico and Canada. Mexico received 72% of the shipments.

Ferrochromium exports to 22 countries increased 82% to 13,218 tons valued at $9,075,000. Canada (35%), the United Kingdom (15%), West Germany (13%), and Sweden and the Netherlands (9% each) were the leading recipients of the shipments.

Chromium and chromium alloys (wrought and unwrought) and waste and scrap exports totaled 703 tons valued at $1,227,000. Of the 33 countries receiving shipments, Argentina accounted for 27%; Canada, 21%; Jamaica, 16%; and West Germany, 9%.

Exports of pigment-grade chromium chemicals totaled 178 tons valued at $431,-000. Canada (46%), Philippines (15%), the Republic of Korea (13%), and the United Kingdom (9%) received 83% of the shipments; the balance was dispersed among 13 other countries. Exports of nonpigment-grade chromium chemicals totaled 2,041 tons valued at $3,998,000. Taiwan received 27%; Canada, 25%; Japan, 10%; West Germany, 7%; and 27 countries received the balance.

Exports of sodium dichromate were nearly the same as in 1974 totaling 10,575 tons valued at $4,569,000. Canada received 33% of the shipments. Countries receiving over 1 million pounds, in decreasing order, were the Republic of Korea, Argentina, Romania, Egypt, and Colombia. Twenty-nine other countries also received shipments.

Imports of chromite in 1975 increased 14% in quantity and 113% in value compared with 1974 totals. Imports increased 17% from the U.S.S.R. and 92% from Southern Rhodesia.

Imports of ferrochromium were at an unprecedented rate totaling 318,809 tons, an increase of 96% over that of 1974. The Republic of South Africa and Japan supplied 40% and 29%, respectively, of the low-carbon ferrochromium imports. Ten other countries supplied the balance. High-carbon ferrochromium was imported from Southern Rhodesia (30%), the Republic of South Africa (29%), and Japan (26%). The balance was supplied by 12 other countries.

Ferrochromium-silicon imports decreased 83% to 4,136 tons valued at $2,041,000. Southern Rhodesia supplied 75%; the Republic of South Africa, 19%; and Taiwan, the balance of the shipments.

Imports of chromium metal, unwrought, and waste and scrap decreased to 1,629 tons valued at $6,630,000 from 1,960 tons valued at $5,388,000 in 1974. Of the six countries supplying imports, the United Kingdom accounted for 51%, and Japan, 46%.

Imports of chromium-containing pigments were as follows: Chrome green, 154 tons; chrome yellow, 2,473 tons; chromium oxide green, 384 tons; molybdenum orange, 235 tons; strontium chromate, 93 tons; and zinc yellow, 609 tons. Total value of these products was $4,327,000, down 51% from that of 1974. Of the total value, chrome yellow accounted for 56%, and zinc yellow, for 16%. The leading suppliers were Japan and Canada with 37% each of total value.

Imports of chromic acid totaled 344 tons valued at $323,000. Of the five countries supplying imports, Japan accounted for 61%; West Germany, 22%; and Poland, 16%.

Sodium chromate and dichromate imports totaled 796 tons valued at $398,000 down 59% in quantity and 65% in value from that of 1974. Of the three countries supplying imports, the U.S.S.R. accounted for 54%; Japan, 42%; and Hong Kong, the balance of the shipments.

Imports of potassium chromate and dichromate decreased to 61 tons from 456 tons reported in 1974. Total value of shipments was $24,622. Sweden accounted for nearly all of the shipments.

Table 8.—U.S. exports and reexports of chromite ore and concentrates
(Thousand short tons and thousand dollars)

Year	Exports		Reexports	
	Quantity	Value	Quantity	Value
1973	21	789	34	989
1974	18	1,430	99	3,101
1975	139	6,896	45	2,111

Table 9.—U.S. imports for consumption of chromite, by grade and country

(Thousand short tons and thousand dollars)

Country	Not more than 40% Cr_2O_3			More than 40% but less than 46% Cr_2O_3			46% or more Cr_2O_3			Total		
	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value
1974:												
Albania	--	--	--	7	3	218	--	--	--	7	3	218
Philippines	253	81	5,517	6	2	135	5	2	130	264	85	5,782
Rhodesia, Southern	5	2	106	--	--	--	67	32	2,426	72	34	2,532
South Africa, Republic of	4	1	86	250	111	4,209	87	41	1,960	341	153	6,255
Turkey	11	5	230	23	10	705	86	41	3,372	120	56	4,307
U.S.S.R	48	17	1,263	--	--	--	250	133	8,175	298	150	9,438
Total	321	106	7,202	286	126	5,267	495	249	16,063	1,102	481	28,532
1975:												
Albania	--	--	--	45	20	2,108	6	3	205	51	23	2,313
Finland	19	4	629	--	--	--	--	--	--	19	4	629
India	--	--	--	--	--	--	12	7	855	12	7	855
Iran	--	--	--	--	--	--	11	5	1,376	11	5	1,376
Philippines	202	66	6,611	--	--	--	8	4	220	210	70	6,831
Rhodesia, Southern	12	5	398	23	10	1,077	103	51	5,706	138	66	7,181
South Africa, Republic of	(1)	(1)	1	218	101	4,513	71	33	1,740	289	134	6,254
Turkey	55	21	2,144	31	13	1,369	87	41	7,278	173	75	10,791
U.S.S.R	57	22	3,253	--	--	--	292	153	21,168	349	175	24,421
Total	345	118	13,036	317	144	9,067	590	297	38,548	1,252	559	60,651

[1] Less than ½ unit.

Table 10.—U.S. imports for consumption of ferrochromium, by country

Year and country	Low-carbon ferrochromium (less than 3% carbon)			High-carbon ferrochromium (3% or more carbon)		
	Gross weight (short tons)	Chromium content (short tons)	Value (thousands)	Gross weight (short tons)	Chromium content (short tons)	Value (thousands)
1974:						
Australia	--	--	--	14	8	$10
Brazil	220	121	r $209	10,362	5,974	2,641
Canada	--	--	--	5	4	5
Finland	--	--	--	2,309	1,169	448
Germany, West	4,736	3,444	2,875	1,702	1,102	576
Japan	6,735	4,602	r 4,163	1,605	997	1,067
Norway	3,050	2,038	1,710	1,651	1,145	674
Rhodesia, Southern	4,959	3,514	2,258	29,204	19,958	6,520
South Africa, Republic of	r 19,980	r 12,794	r 7,692	r 44,526	r 24,614	r 9,041
Sweden	3,503	2,653	2,437	3,993	2,471	1,275
Taiwan	147	110	83	--	--	--
Turkey	r 2,756	r 1,939	r 1,059	--	--	--
Yugoslavia	441	287	304	20,787	13,877	10,877
Total	r 46,527	r 31,502	r 22,790	116,158	71,319	33,134
1975:						
Brazil	886	214	479	15,653	8,885	6,651
Canada	--	--	--	(1)	(1)	1
Finland	--	--	--	6,050	3,092	2,447
France	959	671	1,083	--	--	--
Germany, West	4,415	3,205	5,076	2,084	1,354	1,442
India	969	623	762	661	433	269
Japan	17,782	11,816	23,409	67,188	42,102	51,380
Korea, Republic of	11	6	16	--	--	--
Norway	2,392	1,585	2,458	986	653	661
Rhodesia, Southern	5,238	3,714	5,369	76,855	51,832	33,160
South Africa, Republic of	24,221	14,511	11,002	75,068	41,101	29,219
Sweden	2,853	2,169	4,039	--	--	--
Taiwan	--	--	--	340	213	310
Turkey	1,874	1,297	1,734	441	317	282
Yugoslavia	142	122	162	12,241	8,073	9,219
Total	61,242	39,933	55,589	257,567	158,055	135,041

r Revised.
1 Less than ½ unit.

Table 11.—U.S. import duties

Tariff classification	Article	Rate of duty, Jan. 1, 1976 [1]
	CHROMIUM ORES AND METAL PRODUCTS	
601.15	Chromium ore	Free.
607.30	Ferrochromium, less than 3% carbon	4% ad valorem.
607.31	Ferrochromium, over 3% carbon	0.625 cent per pound on chromium content.
632.18	Unwrought chromium other than alloys: Waste and scrap [2]	5% ad valorem.
	CHROMIUM CHEMICAL AND RELATED PRODUCTS	
420.08	Potassium chromate and dichromate	1.1 cents per pound.
420.98	Sodium chromate and dichromate	0.87 cent per pound.
422.92	Chromium carbide	6% ad valorem.
	CHROMIUM PIGMENTS	
473.10	Chrome green	5% ad valorem.
473.12	Chrome yellow	Do.
473.14	Chromium oxide green	Do.
473.16	Hydrated chromium oxide green	Do.
473.18	Molybdenum orange	Do.
473.19	Strontium chromate	Do.
473.20	Zinc yellow	Do.

1 Not applicable to centrally controlled economy countries.
2 Duty temporarily suspended on waste and scrap.

WORLD REVIEW

Albania.—Work was reportedly in progress on a ferrochromium plant at Burrel in the Mat district. This is the first such facility in Albania and was being constructed with Chinese assistance. Output of the plant will be used at the new Elfasan steel making complex.

Brazil.—Brazil's growing ferroalloy industry has been paced by increased production of silicon, columbium, and chromium ferroalloys. High-carbon ferrochromium production increased from 12,800 tons in 1972 to 35,200 tons in 1974. In addition, production of low-carbon ferrochromium and ferrochromium-silicon was initiated in 1974 as 2,200 tons of low-carbon ferrochromium and 1,900 tons of ferrochromium-silicon were produced.

Finland.—Airco, Inc., signed a 5-year contract for chromite supply specifying "floating quantities." The Finnish chromite will supply up to 75% of the ore needed for the firm's Vargon, Sweden, plant and some tonnage was to be shipped to other Airco plants.

Germany, West.—A chromite ore briquetting plant was being constructed near Duisburg harbor by Mineralhandels Gesellschaft Bouteiller. Reportedly, it will be the first commercial operation of its kind in Europe. Initial briquette production will be by cold bonding using a binder of 3% molasses and 2% to 3% hydrated lime. Cost of the new plant was estimated at $860,000.

Greece.—The Greek Minister for Industry approved prospecting permits for new chromite reserves. Target areas were Verria, near Kozani, and at the foot of Mount Olympus. If new reserves are found and developed, ore production would be for export in order to bolster the balance of trade.

India.—Occurrences, geology, reserves, and 1972 chromite production by individual producers was presented in a series of publications by the Geological Survey of India.[6]

Chromite reserves in India totaled 15.3 million tons. Of the total, 4.6 million tons are measured, 2.6 million tons are indicated, and 8.1 million tons are inferred. Of the measured reserves, 2.2 million tons are high-chromium of which 416,000 tons could be recoverable as lump material.

Jagdish Mines and Metals Pvt. Ltd. announced plans for production of 55,000 tons per year of chromite concentrate and pellets. Technology for the process was developed by the National Metallurgical Laboratory (NML). NML, however, recommended that the firm should export chromium alloys rather than concentrate.

Japan.—Looking toward improved business conditions, Tekkosha Co. Ltd. planned to expand its electrolytic chromium metal plant to 220 tons per month from 165 tons per month. The expansion was scheduled for completion in April 1976.

Nippon Denko Co. Ltd. completed installation of a new 28-megawatt furnace at its Hokuriku plant. The unit replaces two small furnaces and two 4.5-megawatt furnaces were placed on standby. The new unit was rated at 83,000 tons of ferrochromium per year.

Kenya.—A Kenyan company, Western Oil Co., which was carrying out exploratory work in conjunction with Oil Ventures International Inc. of the United States, reportedly discovered promising nickel and chromite deposits in the West Pokot area of Kenya. About 75% of Kenya's foreign exchange earnings are derived from minerals.

Malagasy Republic.—Early in 1975, Japanese ferrochromium producers reportedly established a new company, Madac, in preparation for exploration and development of chromite deposits in the Malagasy Republic. Efforts will be centered in the Adilamena-Tsaratanana district where chromite has been discovered. If developed, chromite output would be shipped to Japanese ferrochromium producers.

Pakistan.—Pakistan's only metallic mineral export was chromite. Production has declined from nearly 30,000 tons per year in the late 1960's to 11,000 tons in 1975. Reasons given for the decline are international competition combined with leasing and labor problems at privately operated mines. The 1980 chromite production target was set at nearly 80,000 tons.

Pakistan's ore reserves have been estimated at 2.6 million tons of chromite. The main deposits are located at Muslimbagh

[6] Geological Survey of India. Geology and Mineral Resources of the States of India. Misc. Pub. No. 30. Part 2—Maharashtra, February 1974; Part 3—Orissa, February 1974; Part 4—Arunachal Pradesh Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, December 1974; Part 5—Bihar, February 1974; Part 6—Tamil Nadu and Pondicherry, May 1974; Part 8—Andhra Pradesh, May 1975.

in Baluchistan. Other unproven chromite deposits are in the Northwest Frontier Province. The Baluchistan Development Authority, with assistance from West Germany, initiated an $800,000 feasibility study for a 16,000 ton annual capacity ferrochromium plant at Muslimbagh.

Philippines.—Output of chromite decreased 2% compared with that of 1974; 23.5% was classified as metallurgical (high-chromium) ore and 76.5% as refractory (high-aluminum) ore. Acoje Mining Co. Inc., sole high-chromium chromite producer, reported 1974 reserves of 1.6 million tons. Consolidated Mines Inc., producer of chromite for refractory use, reported 1974 reserves of 7.9 million tons of chromite.

Rhodesia, Southern.—A description of the mining practices at the mines of African Chrome Mines Ltd., a subsidiary of Union Carbide Corp., was published.[7] The company operates an eluvial chromium ore mine at Impinge and 17 small underground mines in the Mtoroshanga area. For various economic, health and safety, and geologic reasons, mining practices have evolved that improved chromite recovery, reduced labor costs, and improved safety.

South Africa, Republic of.—Production of chromite in the Republic of South Africa totaled 2,288,000 tons, an increase of 11% compared with that of 1974. Of the total, 1,028,000 tons was classified as less than 44% Cr_2O_3; 1,243,000 tons from 44% to 48% Cr_2O_3; and 16,800 tons as over 48% Cr_2O_3. Local sales accounted for 613,000 tons and exports 997,000 tons. Local sales increased 71% while exports decreased 28% compared with those of 1974.

According to reports from Cape Town, South African chromite production will increase from 2.3 million tons in 1975 to 5.8 million tons in 1980. Also, it was expected that ferrochromium output would total 780,000 tons in 1980.

International Minerals & Chemical Corp. (IMC) entered into a feasibility study with Gold Fields of South Africa Ltd. and a subsidiary of Pechiney Ugine Kuhlmann of France for construction of charge ferrochromium plant with a capacity of 60,000 tons per year. A decision was expected near mid-1976; initial production would be in 1978. If built, Gold Fields would operate the plant with chromite ore being supplied by an IMC subsidiary.

Construction of Tubatse Ferrochrome (Pty) Ltd.'s ferrochromium plant at Steelpoort was reportedly begun in April. Tubatse is a joint venture of General Mining Corp. of South Africa and Union Carbide Corp. Startup of the facility was scheduled for late 1976. General Mining will supply the chromite ore requirements from its Eastern Transvaal mines.

Early in 1976, it was announced that N.C. Trading Co. Inc., a U.S. subsidiary of Imetal SA, would be the sales agent for chromium, manganese, and silicon alloys produced by South Africa's South American Minerals & Merchandising Corp. (Samancorp) and Africa Metals Corp. (Amcor).

Turkey.—According to the Turkish Chrome Producers Association, Turkey exported 663,056 tons of chromite during 1975, 25% more than that in 1974. The private sector accounted for 64% of the shipments; the public sector accounted for the balance. Over 51% of the shipments was from the port of Iskenderun. Shipments of ferrochromium decreased 20% to 6,993 tons from 8,695 tons in 1974.

U.S.S.R.—Of the total estimated Soviet chromite production, between 55% and 70% is exported per year; over 80% of this quantity is destined for Western countries. Of the estimated 850,000 tons domestically consumed in 1974, metal production accounted for 45%; refractories, 32%; and chemicals and other products, 23%.

About 94% of Soviet chromite reserves are located in Kazakhstan with the balance in the Ural Mountains. The Donskoye operation in Western Kazakhstan produces over 90% of the Soviet output and is the only supplier of high-quality ore. Chromite deposits in the Urals have a low Cr_2O_3 content as well as a low chromium-to-iron ratio and are used in the chemical and refractory industries. The first chromite concentrator in the U.S.S.R., with an annual capacity of 1 million tons, started production in 1974. The plant operates on low-grade ores that had been previously stockpiled.

Development of the first underground chromite mine continued at Donskoye. When completed in 1980, the mine reportedly will have a capacity of 2 million tons per year.

[7] Kimble, L. G. Mining Practice at African Chrome Mines. Chamber of Mines J. (Rhodesia), v. 17, No. 9, September 1975, pp. 35–43.

The U.S.S.R. asked for bids on various ferroalloy plants consisting of a 1-million-ton-per-year standard ferromanganese plant, a 320,000-ton-per-year ferrochromium plant, and a 60,000-ton-per-year silicon metal plant. The Soviets sought technical and financial assistance from United States ferroalloy producers and from companies in Europe. Financing was being sought from the Export-Import Bank and similar subsidy programs in Europe. Both Airco, Inc. and Union Carbide Corp. studied the proposals but no announcements were made. The target date for completion of the plants would be in 1980.

Table 12.—Chromite: World production, by country
(Thousand short tons)

Country [1]	1973	1974	1975 p
Albania	674	788	e 820
Brazil	r 80	97	e 100
Colombia	13	e 13	e 13
Cuba e	22	22	22
Cyprus	33	37	30
Egypt	1	(2)	(2)
Finland	r 163	170	181
Greece	20	11	25
India	317	434	550
Iran	154	193	e 190
Japan	26	29	26
Malagasy Republic	174	172	214
Pakistan	19	11	e 11
Philippines	640	584	573
Rhodesia, Southern e	600	650	650
South Africa, Republic of	1,818	2,069	2,288
Sudan	35	22	17
Turkey e	r 481	r 734	739
U.S.S.R.e	2,100	2,150	2,290
Yugoslavia	11	1	2
Total	r 7,381	8,187	8,741

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed Bulgaria, North Korea and North Vietnam may also produce chromite, but available information is inadequate for formulation of output estimates.
[2] Less than ½ unit.

TECHNOLOGY

A new mining method was in the final stages of development at General Mining Corp.'s Zwartkop mine in northeastern Transvaal, South Africa. The new method involves longhole drilling, reduces waste haulage to virtually nothing, and significantly reduces labor requirements. Other advantages of the new method include increased face advance and production because of no waste removal, more favorable working conditions, and less expensive drilling costs, both in labor and materials.[8]

Bureau of Mines researchers reported on a process for recovering chromium, nickel, and iron values from stainless steel furnace flue dusts and other wastes generated during the manufacture of stainless steel.[9] Tests were conducted on flue dusts from industrial electric furnaces, mixtures of dusts, and mixtures of various plant wastes. Flue dusts were pelletized with coal breeze and smelted in coreless induction furnaces. The resulting ingots contained 49% to 67% iron, 14% to 19% chromium, 3% to 8% nickel, and small quantities of manganese and molybdenum.

From a laboratory research tool of a decade ago, electroslag remelting (ESR) of steels and superalloys slowly came of age. Estimates of ESR capacity range from 100,000 to 125,000 tons per year. Forecasts indicate capacity will double by 1980. Bethlehem Steel Corp. ordered the nation's largest unit to make ESR ingots up to 60 inches in diameter and weighing up to 75 tons. The electroslag remelting process produces higher quality steels with better workability and results in higher yields with less waste. ESR is used in production of high alloy steels for such applications as large forgings for the electrical industry,

[8] Coal Gold & Base Minerals of Southern Africa. Longholing Hits Gold at Zwartkop. V. 23, No. 6, August 1975, pp. 15, 19, and 21.
[9] Powell, H. E., W. M. Dressel, and R. L. Crosby. Converting Stainless Steel Furnace Flue Dusts and Wastes to a Recyclable Alloy. BuMines RI 8039, 1975, 24 pp.

finishing rolls, and a broad range of tool and die steels. Many of the materials melted contain chromium.

Future energy needs according to many experts will depend on the development of the liquid metal fast breeder reactor. Before the fast breeder becomes a commercial reality, materials of construction must be tested. The Energy Research and Development Administration (ERDA) funded a study known as the national alloy development program to screen materials for use as cladding and duct material in the breeder's fuel assembly. Ten commercially available alloys have been selected for testing, all of which contain chromium. The materials will be exposed to ion bombardment at various facilities throughout the country and to neutron irradiation in the Experimental Breeder Reactor No. 2 in Idaho now under construction.

Various claims have been made in recent years on the benefit of up to 2% additions of chromium oxide (Cr_2O_3) on the compressive strength of portland cements. A study, from the manufacturers' viewpoint, indicated that while compressive strengths can be improved at 8 and 24 hours, the inclusion of Cr_2O_3 in the raw feed always reduces the 28-day values.[10]

National Aeronautics and Space Administration's Lewis Research Center in Cleveland discovered that black chromium plating, a coating used on cameras and to decorate furniture, was about 20% more efficient in retaining heat that other black materials. The discovery could lead to applications in solar heat collection devices.

A new commercial chromium plating process, based on trivalent chromium ions, was claimed by Albright and Wilson Corp. of the United Kingdom. Trademarked Alecra 3, the new system reportedly offers many advantages over conventional chromium plating methods: Elimination of toxic spray in the working environment, easier disposal of spent electrolyte, more uniform metal deposit, and automatic production of microcracked or microporous finishes.[11]

Corning Glass Works reportedly developed a plating chemical system for chromium and nickel with potential for reducing metal consumption by 50% to 90%. The system employs a climbing film evaporator that is attached to the first rinse tank thereby eliminating destruction or dumping of the accumulated plating chemicals.

Concern for the health of workers and others resulted in studies and investigations on the effects of exposure to chromium, particularly hexavalent chromium. In Japan, a high incidence of lung cancer was noted among workers involved in bichromate production. Also, from 1938 to 1971, hexavalent chromium slags have been dumped in or around Tokyo including landfill areas for schools and residential areas. As a result of this information, the Ministry of International Trade and Industry initiated a nationwide survey of chromate pollution. In the United States, the chromium pigments industry alerted its workers and customers to the possibility that prolonged inhalation of chromium pigments could cause lung cancer. The industry sponsored a study to determine the extent of the danger, if any. Two European studies indicated that excess exposure to dusts of chromium pigments could have a relationship with causation of lung cancer.

The Cobo process for pelletizing chromite ores, developed by the Royal Institute of Technology, was discussed.[12] A 20-ton-per-hour pelletizing plant installed by Ferrolegeringar AB at Trollhattan, Sweden, started operating in May. Startup problems were resolved by July. Early data indicates that operating costs total $5.08 per ton while labor represents a cost of $1.75 per ton.

Patent activity for chromium during the year concerned prereduction of chromite pellets in a rotary kiln,[13] refining of molten iron containing chromium,[14] and recovery of chromium and nickel from laterites.[15]

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[10] Imlach, J. A. Assessment of the Role of Chromium in Portland Cement Manufacture. Ceramic Bull., v. 54, No. 9, May 1975, pp. 519–522.

[11] Chemical and Engineering News. Trivalent Chromium Is Basis of Plating Process. V. 53, No. 25, June 25, 1975, pp. 16–17.

[12] Doughty, F. T. C. Operation of a New Pelletizing Process. Iron and Steel Internat., v. 48, No. 6, December 1975, pp. 443–445.

[13] Engstrom, F. (assigned to Aklstrom Osakeyhtio). Metallurgical Production Method. U.S. Pat. 3,867,131, Feb. 18, 1975.

Wienert, F. O. Production of Metallurgical Pellets in Rotary Kilns. U.S. Pat. 3,894,865, July 15, 1975.

[14] Josefsson, E. A. A., F. K. E. Johansson, K. K. A. Almquist, and C. F. Von Hofsten (assigned to Kopparbergs AB). Method of Refining Iron Melts Containing Chromium. U.S. Pat. 3,860,418, Jan. 14, 1975.

[15] Leavenworth, Jr., H. W., E. B. Amey, B. W. Dunning, Jr., R. C. Gabler, Jr., and C. E. Goldsmith (assignors to the United States of America as represented by the Secretary of the Interior, Washington, D.C.). Extraction of Metal Values From Laterite Ores. U.S. Pat. 3,892,639, July 1, 1975.

Clays

By Sarkis G. Ampian [1]

Clays in one or more of the classification categories (kaolin, ball clay, fire clay, bentonite, fuller's earth, or common clay and shale) were produced in 47 States and Puerto Rico. Clay production was not reported in Alaska, the District of Columbia, Rhode Island, or Vermont. The States leading in output were Georgia, 6.2 million tons; Texas, 4.2 million tons; and Ohio, 3.5 million tons; followed in order by North Carolina, California, and Wyoming. Georgia also led in total value of clay output with $195.3 million; Wyoming was second with $36.0 million. Compared with 1974 figures, clay production increased in 10 States and value increased in 16 States. Total quantity of clays sold or used by domestic producers in 1975 was 19% lower in tonnage, but rose about 1% in total value. The total value of clays produced was an alltime high. Increases in value per ton were reported for all clays in 1975 owing to increased labor, fuel, and material costs. The energy crisis or, more specifically, the increasing shortage and costs of fuels continued to cause considerable concern among clay producers and clay product manufacturers. Industrywide efforts were made to both economize and obtain standby fuels for their requirements. The costs of environmental protection equipment and environmental restrictions, and rising capital costs, combined with the energy crisis, continued to adversely affect production during 1975.

Production of the specialty clays—kaolin, ball clay, fire clay, bentonite, and fuller's earth—and common clay and shale, all decreased. A downturn in construction that lowered the demand for building materials (brick, lightweight aggregate, vitrified clay pipe, clay floor and wall tile, etc.) was responsible for the decline in production of common clay and shale. Production of both common clay and shale and fire clay decreased 21%, kaolin 17%, ball clay 14%, fuller's earth 3%, and bentonite 2%.

Kaolin in 1975 accounted for only 11% of the total clay production but for 51% of the domestic clay and shale value.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient clay and clay products statistics in the United States [1]

(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
Domestic clays sold or used by producers:					
Quantity	56,666	59,456	64,351	60,796	49,047
Value	$274,431	$303,022	$354,058	$422,542	$424,556
Exports:					
Quantity	1,973	1,847	2,097	2,451	2,315
Value	$65,329	$66,216	$79,774	$114,212	$120,298
Imports for consumption:					
Quantity	64	67	53	43	38
Value	$1,501	$1,309	$1,879	$2,193	$1,947
Clay refractories, shipments: Value	$236,563	$274,679	$327,265	$410,153	$409,879
Clay construction products, shipments: Value	$641,567	$722,236	$772,723	$694,737	$655,779

[1] Excludes Puerto Rico.

Table 2.—Clays sold or used by producers in the United States in 1975, by State[1]

(Short tons)

State	Kaolin	Ball clay	Fire clay	Bentonite	Fuller's earth	Common clay and shale	Total	Total value
Alabama	126,150	--	249,310	W	--	1,855,246	[2] 2,230,706	[2] $9,077,299
Arizona	--	W	W	25,118	--	W	129,404	482,825
Arkansas	82,012	--	--	--	--	913,180	995,192	2,231,745
California	W	W	105,246	71,896	--	2,209,828	[3,4] 2,386,970	[3,4] 7,373,199
Colorado	--	--	26,559	2,506	--	451,050	480,115	1,100,829
Connecticut	--	--	--	--	--	115,633	115,633	306,531
Delaware	--	--	--	--	--	9,396	9,396	5,638
Florida	22,417	--	--	--	384,550	305,519	712,486	17,062,544
Georgia	4,016,927	--	3,890	--	446,413	1,689,236	6,156,466	195,299,988
Hawaii	--	--	--	--	--	W	W	W
Idaho	13,733	--	W	--	--	W	29,790	283,774
Illinois	--	--	56,635	--	W	1,309,501	[5] 1,366,136	[5] 3,248,768
Indiana	--	--	1,617	--	--	1,092,023	1,093,640	1,960,571
Iowa	--	--	--	--	--	959,311	959,311	1,916,060
Kansas	--	--	--	--	--	1,177,605	1,177,605	1,603,860
Kentucky	--	W	95,925	--	--	681,789	[3] 777,714	[3] 1,483,145
Louisiana	--	--	--	--	--	530,925	530,925	1,132,291
Maine	--	--	--	--	--	125,474	125,474	202,380
Maryland	--	W	--	--	--	580,346	[3] 580,346	[3] 1,450,124
Massachusetts	--	--	--	--	--	124,364	124,364	227,593
Michigan	--	--	--	--	--	1,818,102	1,818,102	3,579,774
Minnesota	W	--	--	--	--	W	W	W
Mississippi	--	W	--	264,039	W	1,152,322	1,592,298	10,605,442
Missouri	104,636	--	854,169	--	W	1,209,273	[5] 2,168,078	[4,5] 13,213,580
Montana	--	--	1,345	177,424	--	44,679	223,448	[6] 1,877,761
Nebraska	--	--	--	--	--	194,975	194,975	416,386
Nevada	2,112	--	--	2,858	--	W	[7] 4,970	[7] 136,316
New Hampshire	--	--	--	--	--	W	W	W
New Jersey	--	--	17,319	--	--	50,000	67,319	371,850
New Mexico	--	--	W	--	--	43,848	[6] 43,848	[6] 60,669
New York	--	W	--	--	--	817,136	[3] 817,136	[3] 1,561,094
North Carolina	W	--	--	--	--	2,581,960	[4] 2,581,960	[4] 4,093,650
North Dakota	--	--	--	--	--	W	W	W
Ohio	--	--	796,758	--	--	2,654,073	3,450,831	11,821,637
Oklahoma	--	--	--	--	--	995,200	995,200	1,700,763
Oregon	--	--	--	1,199	--	118,345	119,544	214,035
Pennsylvania	W	--	781,134	--	--	1,164,167	[4] 1,945,301	[4] 13,671,605
Puerto Rico	--	--	--	--	--	341,342	341,342	440,117
South Carolina	546,893	--	--	--	W	1,150,685	[5] 1,697,578	[5] 12,828,226
South Dakota	--	--	--	W	--	187,354	[2] 187,354	[2] 184,549
Tennessee	--	424,344	--	--	W	885,937	[5] 1,310,281	[5] 9,008,356
Texas	W	54,698	34,248	W	W	3,994,529	4,248,347	13,411,165
Utah	W	--	5,110	1,112	2,174	211,275	[4] 219,671	[4] 547,995
Virginia	--	--	--	--	--	819,458	819,458	1,152,034
Washington	--	--	W	--	--	289,693	[6] 289,693	[6] 777,761
West Virginia	--	--	W	--	--	278,300	[6] 278,300	[6] 439,165
Wisconsin	--	--	--	--	--	2,400	2,400	4,416
Wyoming	--	--	--	2,404,169	--	177,973	2,582,142	36,045,633
Undistributed	419,269	227,205	233,743	278,946	355,927	352,834	[8] 1,406,772	[8] 40,383,192
Total	5,334,149	706,247	3,263,008	3,229,267	1,189,064	35,666,286	49,388,021	424,996,336

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Includes Puerto Rico.
[2] Excludes bentonite.
[3] Excludes ball clay.
[4] Excludes kaolin.
[5] Excludes fuller's earth.
[6] Excludes fire clay.
[7] Excludes common clay and shale.
[8] Incomplete total; remainder included with State totals.

Table 3.—Number of mines from which producers sold or used clay in the United States in 1975, by State

State	Kaolin	Ball clay	Fire clay	Ben-tonite	Fuller's earth	Common clay and shale	Total [1]
Alabama	6	--	8	4	--	28	46
Arizona	--	1	1	3	--	4	9
Arkansas	4	--	--	--	--	19	23
California	10	1	8	11	--	55	75
Colorado	--	--	13	3	--	29	45
Connecticut	--	--	--	--	--	5	5
Delaware	--	--	--	--	--	1	1
Florida	3	--	--	--	6	4	13
Georgia	62	--	1	--	7	20	87
Hawaii	--	--	--	--	--	1	1
Idaho	1	--	1	--	--	2	4
Illinois	--	--	5	--	2	17	24
Indiana	--	--	3	--	--	25	26
Iowa	--	--	--	--	--	15	15
Kansas	--	--	--	--	--	26	26
Kentucky	--	5	9	--	--	10	24
Louisiana	--	--	--	--	--	15	15
Maine	--	--	--	--	--	6	6
Maryland	--	1	--	--	--	8	9
Massachusetts	--	--	--	--	--	3	3
Michigan	--	--	--	--	--	11	11
Minnesota	1	--	--	--	--	2	3
Mississippi	--	4	--	5	4	22	35
Missouri	8	--	74	--	1	18	101
Montana	--	--	1	8	--	10	19
Nebraska	--	--	--	--	--	7	7
Nevada	1	--	--	5	--	1	7
New Hampshire	--	--	--	--	--	2	2
New Jersey	--	--	3	--	--	1	4
New Mexico	--	--	2	--	--	4	6
New York	--	1	--	--	--	15	16
North Carolina	3	--	--	--	--	47	50
North Dakota	--	--	--	--	--	5	5
Ohio	--	--	30	--	--	73	99
Oklahoma	--	--	--	--	--	16	16
Oregon	--	--	--	2	--	13	15
Pennsylvania	2	--	38	--	--	43	74
Puerto Rico	--	--	--	--	--	3	3
South Carolina	16	--	--	--	1	36	53
South Dakota	--	--	--	2	--	4	6
Tennessee	--	35	--	--	1	21	53
Texas	2	7	8	15	1	92	115
Utah	2	--	6	2	1	10	20
Virginia	--	--	--	--	--	15	15
Washington	--	--	5	--	--	16	17
West Virginia	--	--	2	--	--	4	6
Wisconsin	--	--	--	--	--	1	1
Wyoming	--	--	--	97	--	4	101
Total	121	55	218	157	24	789	1,317

[1] Data may not add to totals shown because of mines producing more than one kind of clay.

DOMESTIC PRODUCTION, PRICES, AND FOREIGN TRADE, BY TYPE OF CLAY

KAOLIN

Domestic production of kaolin in 1975 decreased 17%, and the value increased 4%. The average unit value for all grades of kaolin in 1975 was $40.53 per ton, $7.86 higher than in 1974. Kaolin was produced at mines in 14 States. Two States, Georgia (75%) and South Carolina (10%), accounted for 85% of the total U.S. production in 1975. California ranked third, Alabama fourth, and Missouri fifth. Output in 1975 increased in Arkansas, California, and Missouri, and declined in Alabama, Florida, Georgia, Minnesota, Nevada, North Carolina, Pennsylvania, South Carolina, Texas, and Utah. Idaho resumed production in 1975. No kaolin production was reported in 1975 for Colorado.

Kaolin is defined as a white, claylike material approximating the mineral kaolinite. It has a specific gravity of 2.6 and a fusion point of 1,785° C. The other kaolin-group minerals, such as halloysite and dickite, are encompassed.

During 1975 Freeport Kaolin Co., a division of Freeport Minerals Co., which mines and processes kaolin in Georgia, was constructing a 24-mile slurry pipeline from its new mining area near Sandersville, in Washington County, to its processing plant in Gordon. The new mines, complete with degritting facilities and the pipeline, were scheduled for completion by the middle of 1976. Engelhard Minerals and Chemicals Corp., also in Georgia, put a large high-gradient magnetic separator (HGMS) on line during the year, making a total of five operating magnetic separators in the kaolin industry.

Exports of kaolin, as reported by the U.S. Department of Commerce, increased from 849,000 tons valued at $42.1 million in 1974 to 880,000 tons valued at $47.9 million in 1975. The tonnage and value of the kaolin exported in 1975 increased 4% and 14% respectively, over that shipped in 1974. The unit value per ton increased $4.88. This increase in the unit value of kaolin exported was attributed to both the greater percentage of the higher quality paper-coating grades shipped and higher prices.

Kaolin was exported to 60 countries. The major recipients were Japan, 28%; West Germany, 17%; Canada, 16%; Brazil, 11%; and Italy, 10%; and the remaining countries, 18%. Exports increased, except for those to the Netherlands, Italy, the United Kingdom, Belgium-Luxembourg, Canada, Philippines, Sweden, and Mexico. The kaolin producers reported the end use for their exports as follows: Paper coating, 39%; paper filling, 13%; refractories, 38%; rubber, 4%; and others, including adhesives, ceramics, paint, and plastics, 6%.

Kaolin imports in 1975 increased slightly from 19,111 tons valued at $750,000 in 1974 to 19,126 tons valued at $773,000. The United Kingdom supplied nearly 96%; Canada, nearly 4%; and three other countries, less than 1%.

Kaolin prices quoted in the trade journals in 1975, except for fully calcined and air-floated, which advanced, and partially calcined, which was unavailable, were unchanged from 1974. Chemical Marketing Reporter, December 29, 1975, quoted prices as follows:

Waterwashed, fully calcined, bulk carload lots, f.o.b. Georgia, per ton	$120.00–$150.00
Paper-grade, uncalcined, same basis, per ton:	
No. 1 coating	53.00
No. 2 coating	43.00
No. 3 coating	42.00– 43.00
Filler, general purpose, same basis, per ton	27.00– 28.00
Delaminated, waterwashed, uncalcined, paint-grade, 1-micrometer average, same basis, per ton	91.00
Dry-ground, air-floated, soft, same basis, per ton	18.00
National Formulary, powder, 50-pound bags, 5,000-pound lots, works, per pound	.07
National Formulary, colloidal, 150-pound drums, works, per pound	.36

The average unit value reported by domestic kaolin producers was $40.53 per ton, an increase of $7.86 above the 1974 value.

BALL CLAY

Production and value reported for domestically mined ball clay in 1975 decreased 14% and 6%, respectively. Tennessee mines provided 60% of the Nation's output, followed in order of output by Kentucky, Mis-

Table 4.—Kaolin sold or used by producers in the United States, by State

State	1974		1975	
	Short tons	Value	Short tons	Value
Alabama	337,471	$5,954,902	126,150	$3,491,648
Arkansas	80,386	576,911	82,012	1,177,330
California	42,707	399,581	W	W
Colorado	7,950	23,850	--	--
Florida	27,270	W	22,417	850,536
Georgia	4,762,000	183,610,940	4,016,927	177,611,861
Idaho	--	--	13,733	W
Missouri	99,000	W	104,636	W
Nevada	2,406	W	2,112	31,950
South Carolina	769,709	11,127,572	546,893	10,381,747
Other States [1]	263,927	7,171,103	419,269	22,630,797
Total	6,392,826	208,864,859	5,334,149	216,175,869

W Withheld to avoid disclosing individual company confidential data; included with "Other States."

[1] Includes Minnesota, North Carolina, Pennsylvania, Texas, Utah, and data indicated by symbol W.

Table 5.—Kaolin sold or used by producers in the United States, by kind

Kind	1974		1975	
	Short tons	Value	Short tons	Value
Airfloat	1,410,531	$26,283,605	1,102,501	$23,182,773
Calcined	206,483	19,402,465	885,274	59,164,183
Delaminated	221,407	13,328,375	277,209	17,547,878
Unprocessed	1,603,355	29,231,183	[1] 749,044	[1] 7,563,625
Waterwashed	2,951,050	120,619,231	2,320,121	108,717,410
Total	6,392,826	208,864,859	5,334,149	216,175,869

[1] Excludes calcined grades.

Table 6.—Calcined kaolin sold or used by producers in the United States in 1975, by kind

State	High temperature		Low temperature	
	Short tons	Value	Short tons	Value
Georgia	360,985	$21,613,040	117,118	$14,692,551
Other States	[1] 370,195	[1] 21,165,766	[2] 36,976	[2] 1,692,826
Total	731,180	42,778,806	154,094	16,385,377

[1] Includes Alabama, Arkansas, and California.
[2] Includes Idaho, Pennsylvania, and Texas.

Table 7.—Georgia kaolin sold or used by producers, by kind

Kind	1974		1975	
	Short tons	Value	Short tons	Value
Airfloat	920,463	$15,680,712	677,505	$12,560,862
Calcined	159,260	16,956,465	478,103	36,305,591
Delaminated	221,407	13,328,375	277,209	17,547,878
Unprocessed	602,905	18,943,946	[1] 330,667	[1] 3,982,292
Waterwashed	2,857,965	118,701,442	2,253,443	107,215,238
Total	4,762,000	183,610,940	4,016,927	177,611,861

[1] Excludes calcined grades.

sissippi, Texas, Maryland, New York,[2] California, and Arizona. Production in Arizona and Texas increased over that reported in 1974, but California, Kentucky, Maryland, Mississippi, New York, and Tennessee production decreased.

Ball clay is defined as a plastic, white-firing clay used principally for bonding in ceramic ware. The clays are of sedimentary origin and consist mainly of the clay mineral kaolinite and sericite micas.

In 1975, H. C. Spinks Clay Co., Inc.'s. newly completed drying and grinding facility at Gleason, Tenn., was fully operational. This facility expands production of air-floated and mechanically dried clays and eliminates costly hauling from its Gleason mines to other plants. NL Industries, Inc. announced formation of a Mineral Resources department to serve their ball clay, Edgar Plastic Kaolin, Wilson-Snead Bauxite, and Edgar Silica Products units.

The average unit value for ball clay reported by domestic producers rose in 1975 to $18.78 per ton, an increase of $1.44 per ton. Chemical Marketing Reporter, December 29, 1975, listed ball clay prices unchanged from 1974 as follows:

Domestic, air-floated, bags, carload lots, Tennessee, per ton	$18.00–$22.00
Domestic, crushed, moisture-repellent, bulk, carload lots, Tennessee, per ton	8.00– 11.25
Imported, air-floated, bags, carload lots, Atlantic ports, per ton	70.00
Imported, lump, bulk, Great Lakes, per ton	40.50

Ball clay exports in 1975 amounted to 156,000 tons valued at $3.5 million compared with 131,000 tons worth $2.9 million

[2] The famous Albany slip clay is included with ball clay solely for statistical convenience.

Table 8.—Georgia kaolin sold or used by producers, by kind and use

(Short tons)

Use	1974 Airfloat	1974 Unprocessed	1974 Water-washed [1]	1974 Total	1975 Airfloat	1975 Unprocessed	1975 Water-washed [1]	1975 Total
Domestic:								
Adhesives	35,127	--	11,538	46,665	51,700	--	11,182	62,882
Alum (aluminum sulfate) and other chemicals	W	W	W	184,730	W	W	W	229,981
Animal feed	2,644	--	--	2,644	W	--	W	4,925
Catalysts (oil refining)	W	--	W	46,319	W	--	W	54,408
Ceramic floor and wall tile	2,500	--	3,957	6,457	11,475	--	3,319	14,794
Crockery and other earthen-ware	37,325	--	4	37,329	31,530	--	1,871	33,401
Electrical porcelain	3,011	--	--	3,011	6,113	--	1,171	7,284
Face brick	--	--	133	133	--	--	93	93
Fiberglass	W	--	W	91,513	81,215	--	70	81,285
Firebrick, block and shapes	65,100	27,834	1,153	94,087	25,281	12,520	411	38,212
Flue linings and high-alumina brick	W	W	--	73,719	W	W	--	60,035
Foundry sand	154	--	81	235	859	--	--	859
Refractory grogs and crudes	W	W	--	277,362	--	--	226,558	226,558
Ink	W	--	W	13,883	W	--	W	11,332
Medical, pharmaceutical, and cosmetic	1,377	--	609	1,986	222	--	535	757
Paint	57,663	--	170,697	228,360	3,800	--	88,208	92,008
Paper coating	2,000	--	1,308,180	1,310,180	13,614	--	1,428,621	1,442,235
Paper filling	197,613	--	795,846	993,459	169,211	--	434,701	603,912
Plastics	6,833	--	46,725	53,558	5,326	--	38,259	43,585
Portland cement	1,169	64,126	--	65,295	--	W	--	W
Pottery	19,894	--	18,400	38,294	--	--	W	W
Roofing granules	--	--	--	--	32,446	--	--	32,446
Rubber	115,842	--	15,045	130,887	79,917	--	8,590	88,507
Sanitary ware	W	W	15,441	62,362	47,287	W	W	88,973
Miscellaneous, airfloat:								
China/dinnerware; fertilizer; glazes, glass and enamels; hobby ceramics; kiln furniture; mineral wool and insulation; pesticides and related products; roofing granules (1975); roofing tile (1975); starch (1975); unknown uses	53,745	--	--	53,745	21,357	--	--	21,357
Miscellaneous, unprocessed:								
Sewer pipe and data indicated by	--	267	--	267	--	315,147	--	[2] 82,962
Miscellaneous, waterwashed:								
China/dinnerware; gypsum products; mineral oil filtering, clarifying and decolorizing; refractory mortar and cement; waterproofing and sealing; textiles; wire and cable; agriculture; unknown uses	--	--	18,487	18,487	--	--	33,016	33,016
Undistributed	256,978	388,671	99,951	11,153	76,747	--	93,435	(2)
Total	858,975	480,898	2,506,247	3,846,120	658,100	327,667	2,370,040	3,355,807

Export:								
Paint	30	--	17,660	17,690	--	--	13,052	13,052
Paper coating	--	--	532,593	532,593	3,400	--	349,518	352,918
Paper filling	40,537	--	124,203	164,740	5,590	--	114,144	119,734
Plastics	--	--	25,864	25,864	--	--	13,788	13,788
Refractories	17,000	122,007	--	139,007	8,400	--	134,427	142,827
Rubber	3,921	--	1,318	5,239	2,015	--	393	2,408
Miscellaneous	--	--	30,747	30,747	--	3,000	13,393	16,393
Total	61,488	122,007	732,385	915,880	19,405	3,000	638,715	661,120
Grand total	920,463	602,905	3,238,632	4,762,000	677,505	330,667	3,008,755	4,016,927

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes calcined and delaminated.
[2] Incomplete total; remainder included in totals for specific end uses.

Table 9.—South Carolina kaolin sold or used by producers, by kind

Kind	1974 Short tons	1974 Value	1975 Short tons	1975 Value
Airfloat	434,967	$9,364,857	372,417	$9,327,296
Unprocessed	334,742	1,762,715	174,476	1,054,451
Total	769,709	11,127,572	546,893	10,381,747

Table 10.—South Carolina kaolin sold or used by producers, by kind and use

(Short tons)

Kind and use	1974	1975
Airfloat:		
Adhesives	19,394	24,808
Fertilizers	22,015	37,848
Fiberglass	7,006	30,200
Firebrick, block, shapes	W	2,940
Paint	2,962	3,283
Paper filling	W	2,862
Pesticides and related products	22,397	23,990
Plastics	W	2,385
Rubber	241,519	185,966
Other uses [1]	65,684	22,820
Exports [2]	53,990	35,315
Total	434,967	372,417
Unprocessed: Face brick; firebrick, block, and shapes; grogs and crudes, refractory (1975); and sanitary ware (1974)	334,742	174,476
Grand total	769,709	546,893

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes animal feed (1974); crockery and other earthenware; glazes, glass, and enamels; grogs and crudes, refractory (1975); gypsum products; ink; linoleum (1974); paper coating (1974); pottery; sanitary ware; and data indicated by symbol W.
[2] Includes pesticides and related products; plastics (1975); and rubber.

in 1974. Exports increased 19% over that shipped in 1974, but value increased 18%. The unit value of ball clay exported in 1975 declined $0.14 per ton, from $22.43 in 1974 to $22.29. These shipments were made to 18 countries. The major recipients were Canada, 58%, and Mexico, 38%, 16 countries accounted for the remaining 4%.

FIRE CLAY

Fire clay sold or used by domestic producers in 1975 was reported at 3,263,008 tons valued at $35.9 million. Fire clay is defined as detrital material, either plastic or rocklike, containing low percentages of iron oxide, lime, magnesia, and alkalies to enable the material to withstand temperatures of 1,500° C or higher. Fire clay is basically kaolinite but usually contains other materials such as diaspore, ball clay, bauxite clay, and shale. Fire clays commonly occur as underclay below coal seams and are generally used for refractories. Some fire clay was previously reported in other end uses.

Fire clay production was reported in 1975 from mines in 19 States. The first four States in rank, Missouri, Ohio, Pennsylvania, and Alabama, accounted for 82% of the total domestic output.

General Refractories Co., U.S. Refractories Div., began expandiing its Gary, Ind., plant to include a $2 million clay and alumina specialties plant. The new plant will have an annual capacity to produce in excess of 40,000 tons of mortars, plastics, and castables.[3] Louisville Fire Brick Works completed an expansion at its Garber, Ky., plant to be used for producing handmolded firebrick shapes. A fire in 1974 had badly curtailed production.

The Freeport Brick Co., Greenport, Pa. was constructing an entirely new automated plant for startup in early 1976.[4] The new

[3] Ceramic Age. General Refractories Builds Plant at Gary. V. 91, No. 2, March–April 1975, p. 1.

[4] Brick and Clay Record. Industry Newsfront—Plans Underway for New Freeport Brick Plant in Pa. V. 166, No. 5, May 1975, p. 13.

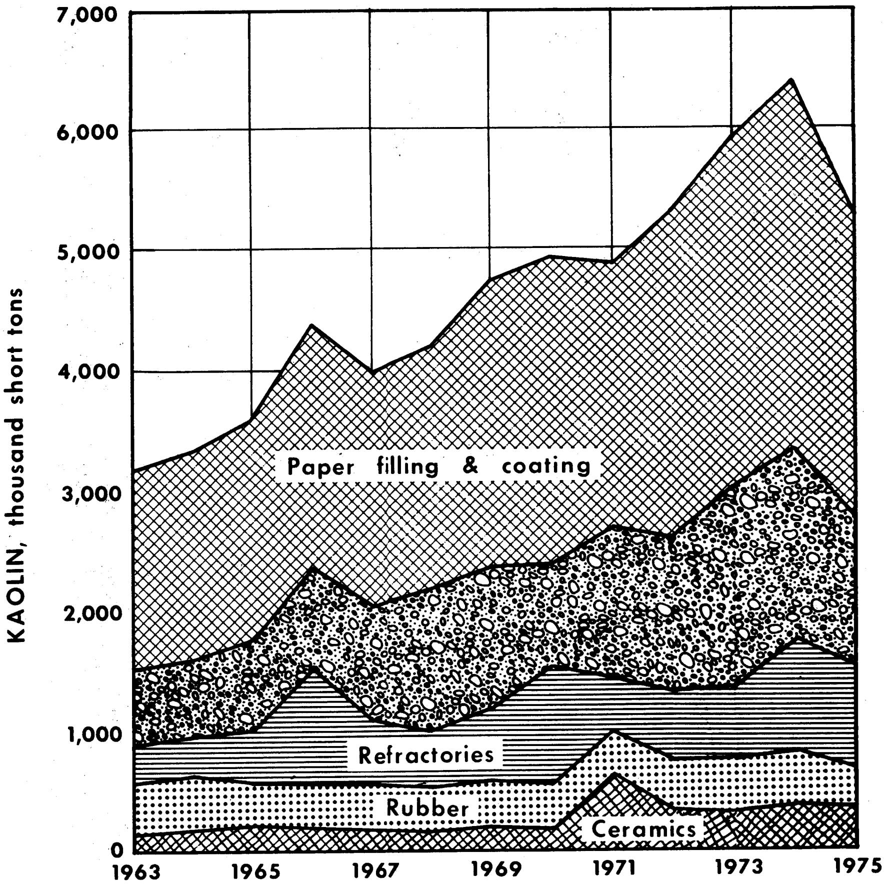

Figure 1.—Kaolin sold or used by domestic producers for specified uses.

plant, expected to cost $3 million, will manufacture both pouring pit and a new line of refractories.

Exports of fire clay decreased from 224,000 tons worth $6.0 million in 1974, to 219,000 tons valued at $7.2 million in 1975. Fire clay exports decreased 2% in tonnage and rose 20% in value. The price of exported fire clay rose by $6.13 to $32.84 per ton.

Fire clay was exported to 46 countries, with Canada and Mexico receiving 45% and 40%, respectively. No imports of fire clay were reported during 1975.

There are no price quotations in domestic journals for fire clay, but the per-ton value reported by producers ranged from $2 to about $38. The reported average unit value for fire clay produced in the United States increased 11% from $9.92 per ton in 1974 to $11.01 in 1975.

BENTONITE

Bentonite production in 1975 decreased 2% in tonnage and increased 15% in value over that of 1974. A general decrease in domestic consumption, particularly in filtering decolorizing, foundry sand, waterproofing and sealing, and exports was noted along with a large increase in drilling mud and slight increases in animal feed and iron ore pelletizing.

Bentonite was produced in 12 States. Increased bentonite production was reported for California, Nevada, Oregon, Texas, and

Table 11.—Kaolin sold or used by producers in the United States, by kind and use

(Short tons)

Use	1974				1975			
	Airfloat	Unprocessed	Water-washed [1]	Total	Airfloat	Unprocessed	Water-washed [1]	Total
Domestic:								
Adhesives	54,521	--	11,538	66,059	76,640	--	11,843	88,483
Alum (aluminum sulfate) and other chemicals	37,841	283,957	1,452	323,250	W	342,222	W	359,242
Animal feed	11,480	--	3,398	14,878	4,114	--	6,509	10,623
Brick, face	355	424,475	498	425,328	273	237,775	203	238,251
Catalysts (oil refining)	12,025	21,628	36,283	69,936	W	W	41,208	78,307
Caulking, putty, sealing	W	--	W	5,016	--	--	--	--
Cement, portland	1,169	110,380	22,726	134,275	--	36,187	18,508	54,695
Ceramic (hobby and artware)	W	W	--	647	W	W	--	13,276
China/dinnerware	12,553	--	9,002	21,555	6,114	--	17,995	24,109
Crockery and other earthenware	68,460	--	4	68,464	36,562	--	1,871	38,433
Electrical porcelain	10,108	--	5,325	15,433	11,609	--	2,089	13,698
Fertilizers [2]	W	--	W	88,087	W	--	W	53,075
Fiberglass	112,905	--	15,079	127,984	137,392	--	6,507	143,899
Firebrick, block, shapes	65,132	382,963	1,153	449,248	28,313	16,780	157,815	202,908
Floor and wall tile, ceramic	12,395	--	4,687	17,082	18,916	--	3,467	22,383
Flue linings and high-alumina brick	W	W	--	73,719	W	W	--	60,215
Foundry sand	154	5,137	81	5,372	859	4,998	210	6,067
Glazes, glass, enamels	507	--	4,733	5,240	W	--	W	4,642
Grogs and crudes, refractory	W	W	--	277,362	1,058	942	237,198	239,198
Gypsum products	1,145	--	3,677	4,822	1,247	--	1,650	2,897
Ink	W	--	W	14,162	W	--	W	11,865
Kiln furniture	2,245	--	--	2,245	1,886	--	--	1,886
Linoleum	W	--	--	W	23	--	--	23
Medical, pharmaceutical, cosmetic	1,377	--	609	1,986	222	--	535	757
Mortar and cement, refractory	--	W	W	1,855	--	1,110	729	1,839
Paint	60,625	--	200,737	261,362	7,083	--	107,518	114,601
Paper coating	5,226	--	1,308,180	1,313,406	13,614	--	1,430,426	1,444,040
Paper filling	201,283	--	810,846	1,012,129	173,562	--	434,701	608,263
Pesticides and related products	24,787	--	3,724	28,511	28,320	--	3,794	32,114
Plastics	7,550	--	46,725	54,275	7,711	--	38,259	45,970
Pottery	23,659	--	18,400	42,059	3,750	W	W	8,644
Roofing granules	--	--	--	--	32,446	--	--	32,446
Rubber	357,441	--	21,161	378,602	265,883	--	17,584	283,467
Sanitary ware	40,927	22,343	19,504	82,774	60,891	W	W	104,076
Textiles	--	--	W	W	--	--	1,842	1,842
Waterproofing and sealing	3,554	--	--	3,554	10	--	--	10
Miscellaneous	163,609	230,285	93,773	[3]26,819	126,346	106,030	96,085	[3]83,190
Total	1,293,033	1,481,168	2,643,295	5,417,496	1,044,844	746,044	2,638,546	4,429,434

Exports:								
Ceramics	2,020	--	3,880	5,900	2,937	3,000	3,488	9,425
Chemical manufacturing	--	--	105	105	--	--	428	428
Paint	30	--	17,810	17,840	--	--	13,052	13,052
Paper coating	--	--	532,593	532,593	3,400	--	349,518	352,918
Paper filling	40,537	--	124,203	164,740	5,590	--	114,144	119,734
Plastics	--	--	25,864	25,864	900	--	13,788	14,688
Grogs, crudes, and other refractories	17,000	122,187	--	139,187	8,400	--	336,812	345,212
Rubber	55,235	--	1,318	56,553	36,165	--	393	36,558
Other	2,676	--	29,872	32,548	265	--	12,435	12,700
Total	117,498	122,187	735,645	975,330	57,657	3,000	844,058	904,715
Grand total	1,410,531	1,603,355	3,378,940	6,392,826	1,102,501	749,044	3,482,604	5,334,149

W Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."
[1] Includes calcined and delaminated.
[2] Includes soil conditioners and mulches.
[3] Incomplete total; remainder included with totals for specific uses.

Table 12.—Ball clay sold or used by producers in the United States, by type and State

Year and State	Airfloat		Unprocessed		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1974						
Tennessee	252,036	$4,487,211	248,287	$3,916,783	500,323	$8,403,994
Texas	--	--	40,731	329,290	40,731	329,290
Other States	[1] 196,310	[1] 4,457,607	[2] 79,812	[2] 976,456	276,122	5,434,063
Total	448,346	8,944,818	368,830	5,222,529	817,176	14,167,347
1975						
Tennessee	262,987	$5,482,026	161,357	$2,367,277	424,344	$7,849,303
Texas	--	--	54,698	466,810	54,698	466,810
Other States	[1] 163,283	[1] 4,093,978	[2] 63,922	[2] 854,956	227,205	4,948,934
Total	426,270	9,576,004	279,977	3,689,043	706,247	13,265,047

[1] Includes Kentucky, Maryland, and Mississippi.
[2] Includes Arizona, California, Kentucky, Mississippi, and New York.

Table 13.—Ball clay sold or used by producers in the United States, by kind and use

(Short tons)

Use	1974			1975		
	Air-float	Un-processed	Total	Air-float	Un-processed	Total
Adhesives	W	--	W	1,003	--	1,003
Alum (aluminum sulfate) and other chemicals	--	--	--	441	--	441
Animal feed	W	--	W	544	--	544
Building brick, face	--	13,000	13,000	--	12,000	12,000
Ceramic hobby and artware	--	--	--	6,334	--	6,334
China/dinnerware	41,770	1,521	43,291	35,330	1,265	36,595
Crockery and other earthenware	--	1,137	1,137	--	914	914
Drilling mud	4,663	--	4,663	W	W	2,564
Electrical porcelain	W	W	45,132	23,984	22,917	46,901
Firebrick, block, shapes	1,200	26,211	27,411	--	30,461	30,461
Glazes, glass, enamels	W	W	1,969	W	W	1,786
High-alumina refractories	W	W	22,019	W	W	21,100
Kiln furniture	W	W	9,349	W	W	8,297
Medical, pharmaceutical, cosmetic	--	2	2	483	1	484
Paint	--	--	--	157	--	157
Pesticides and related products	W	--	W	1,348	--	1,348
Pottery	96,400	73,812	170,212	99,492	27,945	127,437
Rubber	400	--	400	240	--	240
Sanitary ware	82,052	92,649	174,701	24,901	72,371	97,272
Sewer pipe	--	--	--	--	112	112
Tile:						
Floor and wall	60,116	28,358	88,474	82,792	29,752	112,544
Quarry	--	1,142	1,142	--	914	914
Other	--	--	--	--	3	3
Miscellaneous	114,090	95,866	[1] 131,487	62,276	62,533	[1] 91,062
Exports	47,655	35,132	82,787	86,945	18,789	105,734
Total	448,346	368,830	817,176	426,270	279,977	706,247

W Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."
[1] Incomplete total; remainder included with total for each specific use.

Wyoming. Production decreased in Alabama, Arizona, Colorado, Mississippi, Montana, South Dakota, and Utah. No bentonite was reported for Missouri in 1975.

Generally, the high-swelling or sodium bentonites are produced chiefly in Wyoming, Montana, and South Dakota. The calcium or low-swelling bentonites are produced in the other States.

Industrywide improvements were made in environmental controls systems and in automating, bagging, and handling procedures. Some experimental work was also underway exploring the practicality of switching from oil and gas firing in dryers to coal burning.

On December 29, 1975, Chemical Marketing Reporter quoted bentonite prices unchanged. Domestic, 200-mesh, bags, carload lots, f.o.b. mines, was priced from $15.50 to $16.00 per ton; and imported Italian, white, high-gel, bags, 5-ton lots, ex-warehouse, $337.60 ($0.1688 per pound) per ton. The average unit value reported by

Table 14.—Fire clay sold or used by producers in the United States, by State [1]

State	1974		1975	
	Short tons	Value	Short tons	Value
Alabama	316,401	$3,951,624	249,310	$3,057,100
California	157,125	889,369	105,246	424,346
Colorado	53,263	218,638	26,559	110,206
Georgia	W	W	3,890	21,800
Illinois	102,585	672,992	56,635	393,162
Indiana	26,236	118,168	1,617	15,640
Kentucky	116,787	605,966	95,925	621,747
Missouri	924,197	10,760,549	854,169	11,285,147
Montana	W	W	1,345	W
Nevada	104	990	--	--
New Jersey	36,849	232,110	17,319	121,850
Ohio	1,123,506	7,223,029	796,758	5,834,312
Pennsylvania	894,458	11,303,389	781,134	10,362,015
Texas	40,754	316,000	34,248	270,590
Utah	W	W	5,110	29,880
Other States [2]	348,576	4,796,552	233,743	3,384,058
Total	4,140,841	41,089,376	3,263,008	35,931,853

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Refractory uses only.
[2] Includes Arizona, Idaho, New Mexico, Washington, West Virginia, and data indicated by symbol W.

domestic producers for bentonite sold or used in 1975 was $15.63, an increase of $2.35 from the $13.28 average of 1974. Per-ton values reported in the various producing States ranged from $4 to $32 but, as in 1974, the average value reported by the larger producers was near the Wyoming average figure of $14.82.

Bentonite imports in 1975, including chemically activated material, totaled 5,219 tons valued at $617,000 compared with 3,639 tons valued at $699,000 in 1974. The 2,863 tons of chemically activated bentonite was imported from five countries, with Canada supplying 34%; Japan, 32%; Mexico, 31%; and West Germany and Italy, the re-

Table 15.—Bentonite sold or used by producers in the United States, by type and State

State	Nonswelling		Swelling		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1974						
Arizona	W	W	W	W	32,803	$382,545
California	W	W	W	W	56,427	1,520,221
Colorado	800	$9,500	3,324	$28,188	4,124	37,688
Mississippi	333,533	4,599,118	--	--	333,533	4,599,118
Montana	--	--	239,290	2,091,677	239,290	2,091,677
Nevada	--	--	W	W	W	W
Oregon	--	--	1,119	13,423	1,119	13,423
Texas	W	W	W	W	68,575	881,065
Utah	980	11,760	2,173	37,412	3,153	49,172
Wyoming	--	--	2,295,248	28,882,276	2,295,248	28,882,276
Other States	[1] 247,929	[1] 4,225,053	[2] 186,104	[2] 4,071,728	[3] 276,228	[3] 5,512,950
Total	583,242	8,845,431	2,727,258	35,124,704	3,310,500	43,970,135
1975						
Arizona	W	W	W	W	25,118	315,554
California	22,879	$588,228	49,017	$1,459,862	71,896	$2,048,090
Colorado	--	--	2,506	26,241	2,506	26,241
Mississippi	264,039	4,607,219	--	--	264,039	4,607,219
Montana	--	--	177,424	1,800,383	177,424	1,800,383
Nevada	--	--	2,858	104,366	2,858	104,366
Oregon	--	--	1,199	14,388	1,199	14,388
Texas	W	W	--	--	W	W
Utah	812	15,428	300	600	1,112	16,028
Wyoming	--	--	2,404,169	35,623,075	2,404,169	35,623,075
Other States	[1] 186,776	[1] 3,806,710	[2] 117,288	[2] 2,428,544	[3] 278,946	[3] 5,919,700
Total	474,506	9,017,585	2,754,761	41,457,459	3,229,267	50,475,044

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Alabama, Missouri (1974); and data indicated by symbol W.
[2] Includes South Dakota and data indicated by symbol W.
[3] Incomplete total; remainder included with totals for specific States.

Table 16.—Bentonite sold or used by producers in the United States, by type and use

(Short tons)

Use	1974			1975		
	Non-swelling	Swelling	Total	Non-swelling	Swelling	Total
Domestic:						
Adhesives	--	W	W	--	3	3
Animal feed	46,532	129,174	175,706	49,774	126,284	176,058
Building brick, face	--	2,922	2,922	--	1,135	1,135
Catalysts (oil refining)	4,853	26	4,879	7,418	42	7,460
Cement, portland	--	459	459	--	336	336
Drilling mud	15,180	584,508	599,688	25,809	710,446	736,255
Fertilizers	6,490	--	6,490	8,406	--	8,406
Fertilizing, clarifying, and decolorizing:						
Animal oils and mineral oils and greases	83,535	8,269	91,804	48,823	5,687	54,510
Vegetable oils	71,290	--	71,290	63,876	--	63,876
Foundry sand	270,395	467,660	738,055	242,133	465,800	707,933
Glazes, glass, and enamels	--	209	209	--	141	141
Gypsum products	--	506	506	--	383	383
Medical, pharmaceutical, cosmetic	200	14,678	14,878	58	2,019	2,077
Oil and grease absorbents	W	W	14,860	--	--	--
Paint	--	4,915	4,915	--	4,102	4,102
Pelletizing (iron ore)	--	870,464	870,464	--	878,022	878,022
Pesticides and related products	21,525	2,328	23,853	2,462	517	2,979
Pet absorbent	W	W	6,319	--	30,134	30,134
Pottery	307	--	307	--	--	--
Sewer pipe (vitrified)	100	--	100	--	--	--
Tile:						
Floor and wall, ceramic	--	--	--	488	--	488
Roofing	13,129	--	13,129	7,566	--	7,566
Waterproofing and sealing	1,407	84,888	86,295	1,820	33,629	35,449
Miscellaneous	27,060	54,348	[1] 60,229	3,052	61,984	65,036
Total	562,003	2,225,354	2,787,357	461,685	2,320,664	2,782,349
Exports:						
Drilling mud	--	152,912	152,912	--	128,848	128,848
Foundry sand	16,781	215,142	231,923	12,821	154,391	167,212
Pelletizing (iron ore)	--	112,833	112,833	--	142,839	142,839
Other	4,458	21,017	25,475	--	8,019	8,019
Total	21,239	501,904	523,143	12,821	434,097	446,918
Grand total	583,242	2,727,258	3,310,500	474,506	2,754,761	3,229,267

W Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."

[1] Incomplete total; remainder included with total for each specific use.

mainder. Special-purpose Italian bentonite was also imported in 1975.

Bentonite exports in 1975 decreased from 714,000 tons in 1974 to 697,000 tons in 1975; value increased from $28.1 million in 1974 to $39.5 million in 1975. Although the tonnage exported decreased 2% from that shipped in 1974, the value increased 40%. The increase in value was the result of a $17.19 increase in the unit value of exported bentonite, from $39.41 per ton in 1974 to $56.60 per ton in 1975. This increase in per-ton value was attributed to a large increase in the value of the higher cost drilling mud and foundry-grade bentonites shipped. Exports in previous years consisted of a larger percentage of the lower cost pelletizing grades. Domestic bentonite producers were facing increased competition in foreign markets. Bentonite from the Greek Island of Milos was being blended with the U.S. clay for pelletizing Canadian taconite ores on a large scale.

Bentonite was again exported to 83 countries. The major recipients were Canada, 44%; Australia and Peru, 8% each; the United Kingdom, 7%; West Germany and the Netherlands, 4% each; Japan, Saudi Arabia, and Singapore, 3% each; and the others, 16%. Domestic bentonite producers reported the end use of their exports were foundry sand, 37%; iron ore pelletizing, 32%; drilling mud, 29%; and others, including ceramics, mineral wool and insulation, soil conditioner, and waterproofing and sealing, 2%.

FULLER'S EARTH

Production of fuller's earth in 1975 decreased 3% in quantity and increased 18%

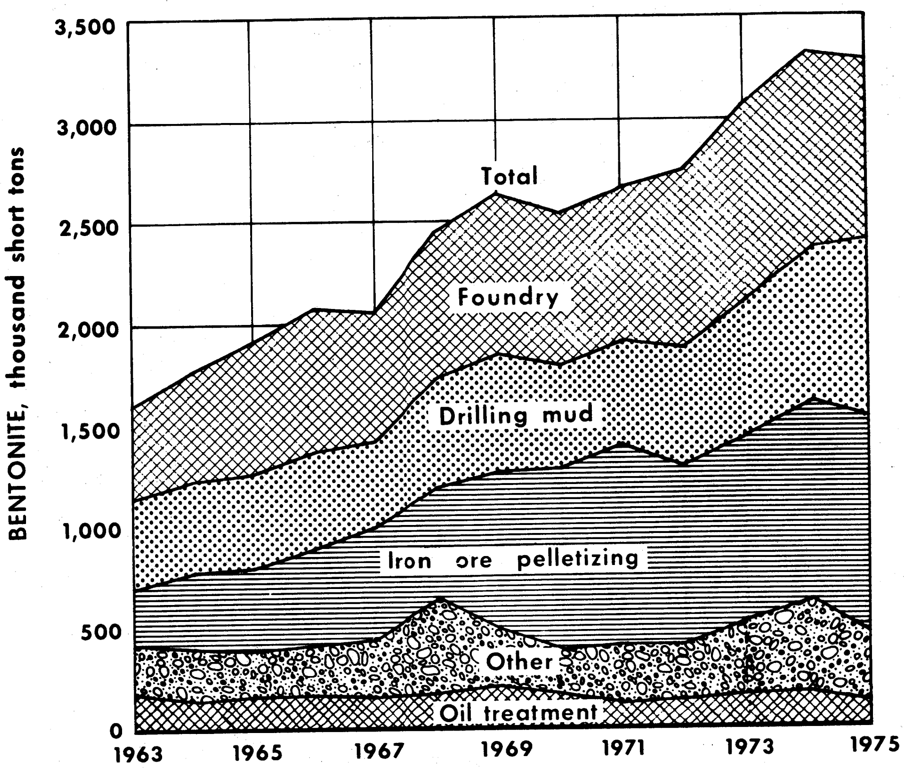

Figure 2.—Bentonite sold or used by domestic producers for specified uses.

in total value. The unit value assigned by domestic producers increased $6.29 in 1975 to $35.74 per ton. This increase in value was due to large increases in unit value by Florida, Illinois, Missouri, Tennessee, and Texas producers.

Fuller's earth production was reported from operations in nine States, a decrease of two from that of 1974. The two top producing States, Georgia (38%) and Florida (32%), accounted for 70% of the domestic production; the other seven States accounted for the remaining 30%. Illinois, Missouri, South Carolina, Tennessee, and Texas showed gains in production, but production in Florida, Georgia, and Mississippi declined. Utah's tonnage was unchanged. California and Nevada did not report any production in 1975.

Fuller's earth is defined as a nonplastic clay or claylike material, usually high in magnesia, which has adequate decolorizing and purifying properties.

Production from the region that includes Attapulgus (Decatur County), Ga., and Quincy (Gadsden County), Fla., is composed predominantly of the distinct lath-shaped amphibole clay mineral attapulgite. Most of the fuller's earth produced in the other areas of the United States contains varieties of montmorillonite.

Prices for fuller's earth were not publicly quoted in 1975, but the value per ton for attapulgite reported by producers ranged from $20 to over $70; montmorillonite prices ranged from $18 to $48.

Exports of fuller's earth to 38 countries decreased from 56,000 tons valued at $3.2 million in 1974 to 42,000 tons valued at $2.8 million in 1975. Export tonnage decreased 25%, and value decreased 12%. The unit value of exported fuller's earth rose

$9.91 per ton. The major recipients were the United Kingdom, 26%; Canada, 24%; the Netherlands, 12%; Belgium-Luxembourg, 10%; West Germany, 5%; France, Italy, Singapore, and the United Arab Emirates more than 2% each; and other countries, the remainder.

Imports of fuller's earth in 1975 were 65 tons, valued at $6,000, all from the United Kingdom.

Table 17.—Fuller's earth sold or used by producers in the United States, by type and State

Year and State	Attapulgite		Montmorillonite		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1974						
Florida	412,523	$13,717,627	--	--	412,523	$13,717,627
Georgia	W	W	W	W	489,204	15,440,560
Nevada	--	--	80	$2,386	80	2,386
Utah	--	--	2,174	46,000	2,174	46,000
Other States	[1] 367,854	[1] 11,792,146	[2] 442,009	[2] 10,502,555	[3] 320,659	[3] 6,854,141
Total	780,377	25,509,773	444,263	10,550,941	1,224,640	36,060,714
1975						
Florida	384,550	$15,755,032	--	--	384,550	$15,755,032
Georgia	W	W	W	W	446,413	14,273,864
Utah	--	--	2,174	$49,000	2,174	49,000
Other States	[1] 334,884	[1] 12,619,197	[2] 467,456	[2] 14,075,347	[3] 355,927	[3] 12,420,680
Total	719,434	28,374,229	469,630	14,124,347	1,189,064	42,498,576

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Texas and data indicated by symbol W.
[2] Includes California (1974), Illinois, Mississippi, Missouri, South Carolina, Tennessee, and data indicated by symbol W.
[3] Incomplete total; remainder included in Georgia.

Table 18.—Fuller's earth sold or used by producers in the United States, by type and use

(Short tons)

Use	1974			1975		
	Attapulgite	Montmorillonite	Total	Attapulgite	Montmorillonite	Total
Domestic:						
Adhesives	1,525	--	1,525	5,030	--	5,030
Animal feed	W	--	W	40	--	40
Cement, portland	W	W	19,690	W	W	17,632
Drilling mud	75,976	--	75,976	87,981	--	87,981
Fertilizers	38,966	15,550	54,516	30,840	12,065	42,905
Filtering, clarifying and decolorizing mineral oils and greases	30,917	211	31,128	22,262	--	22,262
Medical, pharmaceutical, cosmetic	16	--	16	61	--	61
Oil and grease absorbents	268,918	140,816	409,734	200,934	148,141	349,075
Paint	1,662	--	1,662	2,063	--	2,063
Paper coating	71	--	71	4	--	4
Pesticides and related products	143,164	36,415	179,579	149,077	49,250	198,327
Pet absorbent	139,859	218,134	357,993	151,578	222,864	374,442
Rubber	--	--	--	4	--	4
Miscellaneous	9,062	21,117	[1] 10,489	8,088	19,051	[1] 9,507
Total	710,136	432,243	1,142,379	657,962	451,371	1,109,333
Exports:						
Catalysts (oil refining)	W	W	8,907	W	W	3,280
Drilling mud	1,256	--	1,256	W	--	W
Fertilizers	W	W	4,764	W	W	2,039
Oil and grease absorbents	19,011	5,222	24,233	17,077	4,544	21,621
Pet absorbent	30,310	4,406	34,716	32,311	5,734	38,045
Miscellaneous	19,664	2,392	[1] 8,385	12,084	7,981	[1] 14,746
Total	70,241	12,020	82.261	61,472	18,259	79,731
Grand total	780,377	444,263	1,224,640	719,434	469,630	1,189,064

W Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."
[1] Incomplete total; remainder included in total for each specific use.

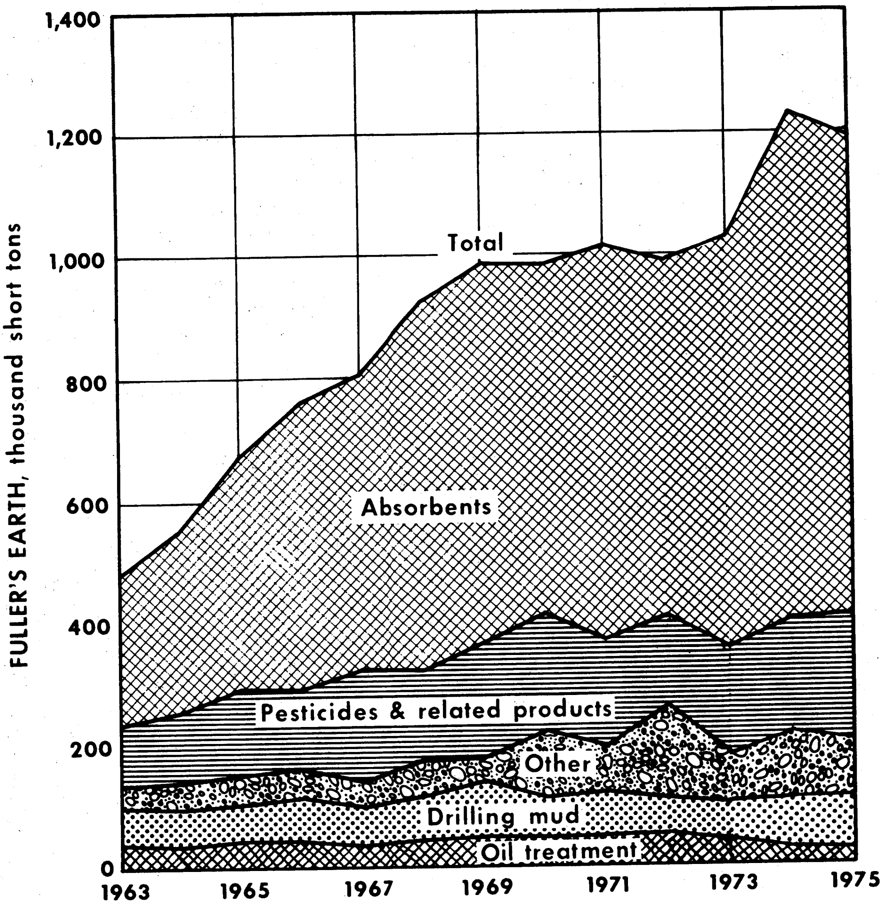

Figure 3.—Fuller's earth sold and used by domestic producers for specified uses.

COMMON CLAY

Domestic production of common clay and shale in 1975 totaled 35.3 million tons valued at $66.2 million. Common clay and shale represented 72% of the quantity and 16% of the value of the total clay and shale produced domestically in 1975. In addition, Puerto Rican production of common clay and shale was reported at 341,342 tons valued at $440,117. Domestic output in 1975 decreased 21% below that reported for 1974.

Common clays and shales are for the most part used by the producer in fabricating or manufacturing a product. Less than 10% of the total clay and shale output was sold. The average unit value for all common clay and shale produced in the United States and Puerto Rico in 1975 was $1.87 per short ton, $0.13 more than in 1974. The range in unit value reported for the bulk of the output was from $1 to $2 per ton.

Common clay is defined as a clay or clay-like material which is sufficiently plastic to permit ready mold and vitrification below 1,100° C. Shale is a consolidated sedimentary rock composed chiefly of clay minerals that has been both laminated and indurated while buried under other sediments. These materials are used in the manufacture of structural clay products, such as brick and drain tile, portland cement clinker, and bloated lightweight aggregate.

In 1975, a new fully automated facility capable of producing 70,000 king-size bricks per day, engineered and designed by The Lingl Corp., was put onstream by Commercial Brick Corp. on the site of the old Wewoka Brick and Tile plant, Wewoka, Okla., which closed in 1973.[5] The new facility is the first plant in this country designed and equipped for total automation with all Lingl equipment including dehackers. The kiln is 18 brick wide and natural gas fired. A Lingl dehacker was also undergoing shakedown runs prior to assembly at Maryland Clay Products' plant in Beltsville, Md. Plant expansions and/or renovations were underway at one of General Wadsworth's Brick Corp. plants, at the American Olean Tile Co. plant in Quakertown, Pa., El Paso Brick Co. in Texas, and at Marion Brick's Bigler, Pennsylvania plant. The Marion Brick Co. expansion will boost production to 40 million brick per year. Officials of the Acme Brick Co. announced that Eustace, Tex., was chosen as the location for the company's newest plant.

The output of the energy-intensive common clay and shale industry was curtailed by shortages of fuel, labor, and a down-

[5] Ceramic Age. New Brick Facility Ready in '75. V. 91, No. 1, January–February 1975, pp. 1, 5.

Table 19.—Common clay and shale sold or used by producers in the United States, by State [1]

State	1974		1975	
	Short tons	Value	Short tons	Value
Alabama	2,341,508	$3,391,714	1,855,246	$2,528,551
Arizona	163,816	224,345	W	W
Arkansas	903,711	1,020,486	913,180	1,054,415
California	2,239,161	4,771,235	2,209,828	4,900,763
Colorado	597,943	1,308,038	451,050	964,382
Connecticut	155,579	363,446	115,633	306,531
Delaware	14,049	8,429	9,396	5,638
Florida	368,556	543,836	305,519	456,976
Georgia	2,440,755	4,884,762	1,689,236	3,392,463
Idaho	9,295	10,348	W	W
Illinois	1,484,461	3,071,455	1,309,501	2,855,606
Indiana	1,065,897	1,828,468	1,092,023	1,944,931
Iowa	960,221	1,869,045	959,311	1,916,060
Kansas	1,310,576	1,785,130	1,177,605	1,603,860
Kentucky	731,423	870,596	681,789	861,398
Louisiana	770,254	1,425,260	530,925	1,132,291
Maine	146,333	182,716	125,474	202,380
Maryland	884,189	2,065,548	580,346	1,450,124
Massachusetts	217,685	378,780	124,364	227,593
Michigan	2,160,928	4,073,629	1,818,102	3,579,774
Mississippi	1,492,249	2,047,255	1,152,322	1,974,623
Missouri	1,541,656	2,390,768	1,209,273	1,928,433
Montana	58,624	97,696	44,679	77,378
Nebraska	182,394	413,878	194,975	416,386
New Hampshire	33,827	55,325	W	W
New Jersey	66,827	292,100	50,000	250,000
New Mexico	55,336	316,628	43,848	60,669
New York	1,450,564	2,348,006	817,136	1,561,094
North Carolina	3,421,825	4,648,355	2,581,960	4,093,650
Ohio	3,201,636	6,265,219	2,654,073	5,987,325
Oklahoma	1,288,938	2,105,382	995,200	1,700,763
Oregon	138,649	229,186	118,345	199,647
Pennsylvania	1,837,522	5,192,310	1,164,167	3,309,590
Puerto Rico	291,007	332,481	341,342	440,117
South Carolina	1,527,252	2,637,570	1,150,685	2,446,479
South Dakota	189,592	201,654	187,354	184,549
Tennessee	1,137,603	1,372,210	885,937	1,159,053
Texas	5,045,922	8,364,555	3,994,529	7,593,599
Utah	201,201	516,929	211,275	453,087
Virginia	1,956,746	2,613,820	819,458	1,152,034
Washington	269,425	698,235	289,693	777,761
West Virginia	338,817	520,315	278,300	439,165
Wisconsin	2,385	4,393	2,400	4,416
Wyoming	215,903	456,509	177,973	422,558
Other States [2]	289,104	523,839	352,834	633,835
Total	45,201,344	78,721,884	35,666,286	66,649,947

W Withheld to avoid disclosing individual company confidential data; included with "Other States."

[1] Includes Puerto Rico.

[2] Includes Hawaii, Minnesota, Nevada, North Dakota, and data indicated by symbol W.

turn in construction rates in 1975. Industrywide attention was focusing on coal firing as a possible escape from the high cost and shortages of oil and gas.

Exports of common clay and shale are not tallied by the U.S. Department of Commerce. Most countries have local deposits of either clays or shales that are adequate for manufacturing structural clay products, cement clinker, and lightweight aggregates, and thus have no need to import such materials.

CONSUMPTION AND USES

The manufacture of heavy clay products (building brick, sewer pipe, drain, roofing, structural, terra cotta, and other tile), portland cement and clinker, and lightweight aggregate accounted for 36%, 20%, and 16%, respectively, of the total 1975 domestic consumption of clays. In summary, 72% of all clay produced in 1975 was consumed in the manufacture of these clay- and shale-based construction materials. The foregoing clay tonnage relationships were similar to those reported for 1974. The utilization of clays in 1975 for heavy clay products and portland cement decreased 24% and 18%, respectively, over that reported in 1974.

Heavy Clay Products.—The values reported for shipments of heavy clay products in 1975 declined 6% to $656 million from the 1974 value of $695 million. The trends in corresponding quantities were less consistent. Thousand-unit counts for building or common face brick decreased 12% in 1975 from that shipped in 1974, shipments of glazed and unglazed ceramic tile and glazed brick, and of clay floor and wall tile decreased 19% and 14%, respectively. The tonnage of unglazed structural tile decreased 12%, and vitrified clay sewer pipe and fittings shipped during the year declined 18%. The value of these shipments except for structural tile was unchanged from 1974, declined 5% each for building brick and clay and floor and wall tile, 7% for clay sewer-pipe, and 15% for ceramic tile.

Lightweight Aggregate.—Consumption of clay and shale in the making of lightweight aggregate declined in 1975 to 8,138,889 tons. This was a 19% decrease from the 10.0 million tons used in 1974.

The tonnage of raw material mentioned in tables 20 and 23 for lightweight aggregate production refers only to clay and shale and does not include the quantity of slate and blast furnace slag similarly used. In 1975, 510,000 tons of slate was expanded for lightweight aggregate, 48% below the 1974 figure of 983,196 tons. The National Slag Association reported the amount of slag used for lightweight concrete aggregate and in block manufacture decreased 17%, from 1,316,000 tons in 1974 to 1,092,000 tons in 1975.

Refractories.—All types of clay were used in manufacturing refractories. Fire clay, bentonites, and kaolin accounted for 66%, 16%, and 12%, respectively, of the total clays used for this purpose. Bentonite was used primarily as a bonding agent in proprietary foundry formulations. Minor tonnages of ball clay (4%), fuller's earth, and common clay and shale (the remaining 2%) were also used, primarily as bonding agents.

The tonnage used for refractories in 1975 increased to slightly more than 9% of the total clays produced. This slight increase in the use of clay-based refractories continued for a fourth year, a reversal in the downward pattern set for a number of years. The increase was due primarily to both the continued expansion in refractory aggregate production and an upsurge in the manufacturing of more conventional brick-type refractories. Refractory aggregates are used mostly in plastic, gunning, ramming, and castable mixes.

Filler.—All clays are used to some extent as fillers in one or more areas of use. Kaolin, fuller's earth, and bentonite are the principal filler clays. Kaolin was used in the manufacture of a large number of products, such as paper, rubber, plastics, paint, and fertilizers. Fuller's earth was used primarily in pesticides and fertilizers. Clays in pesticides and fertilizers are used either as carriers, diluents, or prilling agents. Bentonites were used mainly in animal feed.

Six percent of the clay produced in 1975 was used in filler applications. Of all the clay used for these purposes, kaolin accounted for 85%, fuller's earth 8%, and bentonite 6%. Ball clay and common clay and shale accounted for the remainder. The total amount of kaolin consumed by this end use category decreased 17%. In the individual kaolin categories, increases were recorded in adhesives (34%), paper coating (10%), and pesticides (13%). Decreases were noted in fertilizers (40%), paint (56%), paper filling (40%), plastics (15%), and rubber (25%). Total quantity of fuller's earth used in insecticides and fungicides increased 10%.

Absorbent Uses.—Absorbent uses for for clays, 753,651 tons, consumed nearly 2% of the total 1975 clay production. Demand for absorbents in 1975 decreased 4% from that reported for 1974. Fuller's earth was the principal clay used in absorbent applications; 96% of the entire output was consumed for this purpose. Bentonite was used to a lesser degree. Demand for clays in pet absorbent, representing 54% of the 1975 absorbent demand, increased 11% from that reported for 1974. Demand for use in floor absorbents, chiefly to absorb hazardous oily substances, represented the remaining 46% of absorbent demand and decreased 18% from the 1974 figure.

Drilling Mud.—Demand for clays in rotary-drilling muds increased 21% in 1975, from 681,755 tons in 1974 to 827,962 tons. This increase in demand, mostly in exploratory gas well drilling and to a lesser degree in oil well drilling, was spurred by the deregulation of "new" gas introduced into the interstate market after April 6, 1972. Drilling muds consumed nearly 2% of the entire 1975 clay production. Swelling-type bentonite is the principal clay used in drilling-mud mixes, although fuller's earth or nonswelling bentonite is also used to a limited extent. Bentonite and fuller's earth accounted for nearly 100% of the total amount of clay used for this purpose. Small amounts of ball clay and common clay and shale were used in specialized formulations.

Floor and Wall Tile.—Common clay and shale, ball clay, fire clay, kaolin, and bentonite, in order of demand, were used in manufacturing floor, wall, and quarry tile. This tile end use category accounted for less than 1% of the total clay production in 1975. Demand in 1975, 398,707 tons, decreased 16% from that shown in 1974.

Pelletizing Iron Ore.—Bentonite is used as a binder in forming iron ore pellets. Demand, continuing the general trend, increased slightly in 1975 to 878,022 tons. This rise in the use of bentonite for iron ore pelletizing, reflecting an upturn in steel production, was accomplished in spite of inroads made by cheaper foreign bentonites into a traditional U.S. clay market. Of the total bentonite produced in 1975, about 32% of the swelling variety (as in 1974) was consumed for this purpose. U.S. deposits continued to be the major source for swelling bentonites.

Pottery.—The total demand for clays in the manufacture of pottery, sanitary ware, china/dinnerware, and related products, excluding clay flower pots, accounted for about 1% of the total 1975 clay output. The total clay demand, principally ball and kaolin clays, declined from approximately 752,000 tons in 1974 to approximately 616,000 tons in 1975.

Table 20.—Clays sold or used by producers in the United States in 1975, by kind and use, including Puerto Rico

(Short tons)

Use	Ball clay	Bentonite	Common clay and shale	Fire clay (refractory only)	Fuller's earth	Kaolin	Undistributed [1]	Total
Adhesives	1,003	3	--	--	5,030	88,483	--	94,519
Alum (aluminum sulfate) and other chemicals)	441	[2]	--	[2]	[2]	359,242	6,672	366,355
Animal feed	544	176,058	19	--	40	10,623	--	187,284
Asphalt emulsion and tiles	[2]	[2]	--	--	--	--	4,635	4,635
Building brick:								
Common	[2]	[2]	2,107,951	--	--	27	450	2,108,428
Face	12,000	1,135	13,291,754	67,504	--	238,251	--	13,610,644
Catalysts (oil refining)	[2]	7,460	--	--	[2]	78,307	12,281	98,048
Cement, portland	--	336	9,849,058	--	17,632	54,695	--	9,921,721
Ceramic hobby and artware	6,334	--	--	--	--	13,276	--	19,610
China/dinnerware	36,595	[3]	--	--	--	24,109	--	[4] 60,704
Crockery and other earthenware	914	--	5,597	[2]	[2]	38,433	21,277	66,221
Drilling mud	2,564	736,255	1,162	--	87,981	--	--	827,962
Electrical porcelain	46,901	--	--	955	--	13,698	--	61,554
Fertilizers	--	8,406	91	--	42,905	53,075	--	104,477
Fiberglass	--	--	--	--	--	143,899	--	143,899
Filtering, clarifying, decolorizing:								
Animal oil	--	37,702	--	--	--	--	--	37,702
Mineral oils and greases	--	16,808	--	--	22,262	--	--	39,070
Vegetable oils	--	63,876	--	--	--	--	--	63,876
Firebrick, block, shapes	30,461	[3]	--	2,150,997	--	202,908	--	[4] 2,384,366
Flower pots	--	--	51,719	--	--	--	--	51,719
Flue linings	--	--	103,647	48,099	--	[3]	--	[4] 151,746
Foundry sand	--	707,933	--	153,136	--	6,067	--	867,136
Glazes, glass, enamels	1,786	141	--	41,448	--	4,642	--	48,017
Grogs and crudes, refractory	[3]	--	--	116,284	--	239,198	--	[4] 355,482
Gypsum products	--	383	25,000	--	--	2,897	--	28,280
High aluminum (minimum 50% Al_2O_3) refractories	21,100	--	--	241,513	--	52,800	--	315,413
Ink	--	--	--	--	--	11,865	--	11,865
Kiln furniture	8,297	--	--	120	--	1,886	--	10,303
Lightweight aggregate:								
Concrete block	--	--	5,061,686	--	--	--	--	5,061,686
Structural concrete	--	--	1,967,842	--	--	--	--	1,967,842
Highway surfacing	--	--	800,509	--	--	--	--	800,509
Other	--	--	308,852	--	--	--	--	308,852

See footnotes at end of table.

Table 20.—Clays sold or used by producers in the United States in 1975, by kind and use, including Puerto Rico—Continued

(Short tons)

Use	Ball clay	Bentonite	Common clay and shale	Fire clay (refractory only)	Fuller's earth	Kaolin	Undistributed [1]	Total
Linoleum	--	--	--	--	--	23	--	23
Medical, pharmaceutical, cosmetic	484	2,077	--	--	61	757	--	3,379
Mortar and cement, refractory	(2)	--	--	196,329	(2)	1,839	64,477	262,645
Oil and grease absorbents	--	--	--	--	349,075	--	--	349,075
Paint	157	4,102	1,244	--	2,063	114,601	--	122,167
Paper coating	(2)	(2)	--	--	4	1,444,040	1,353	1,445,397
Paper filling	(2)	(2)	--	--	--	608,263	8,480	616,743
Pelletizing (iron ore)	--	878,022	--	--	--	--	--	878,022
Pelletizing (other)	--	--	--	19,200	--	--	--	19,200
Pesticides and related products	1,348	2,979	--	--	198,327	32,114	--	234,768
Pet absorbent	--	30,134	--	--	374,442	--	--	404,576
Plastics	--	--	(2)	--	(2)	45,970	576	46,546
Plug, tap, wad	--	--	--	8,452	--	--	--	8,452
Pottery	127,437	--	58,087	25,154	--	8,644	--	219,322
Roofing granules	--	--	(2)	8,305	(2)	32,446	1,735	42,486
Rubber	240	--	--	--	4	283,467	--	283,711
Sanitary ware	97,272	--	--	--	--	104,076	--	201,348
Sewer pipe, vitrified	112	--	1,120,331	45,363	--	(3)	--	[4] 1,165,806
Tamping dummies	--	--	7,280	--	--	--	--	7,280
Textiles	--	--	--	--	--	1,842	--	1,842
Tile:								
Drain	--	--	435,101	--	--	--	--	435,101
Floor and wall, ceramic	112,544	488	78,228	32,382	--	22,383	--	246,025
Quarry	914	--	151,768	--	--	--	--	152,682
Roofing	--	7,566	72,400	--	--	(3)	--	[4] 79,966
Structural	--	--	106,940	--	--	--	--	106,940
Terra cotta	--	--	27,462	(2)	(2)	--	1,286	28,748
Other	3	--	--	--	--	--	--	3
Waterproofing and sealing	(3)	35,449	2,354	--	--	10	--	[4] 37,813
Miscellaneous [5]	6,250	57,686	5,897	7,088	2,832	90,578	--	170,331
Undistributed	84,812	7,350	1,920	22,465	6,675	--	--	(6)
Exports	105,734	446,918	22,387	78,214	79,731	904,715	--	1,637,699
Total	706,247	3,229,267	35,666,286	3,263,008	1,189,064	5,334,149	(6)	49,388,021

[1] Total of clays indicated by footnote 2.
[2] Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."
[4] Incomplete figure; remainder included with "Miscellaneous."
[5] Includes graphite anodes, mineral wool and insulation, unknown uses, and data indicated by footnote 3.
[6] Included with total for each specific use.

Table 21.—Shipments of principal structural clay products in the United States

Products	1971	1972	1973	1974	1975
Unglazed common and face brick:					
Quantity ---------------million standard brick--	7,570	8,402	8,674	6,673	5,854
Value ---------------million dollars--	$346	$404	$451	$376	$358
Unglazed structural tile:					
Quantity ---------------thousand short tons--	157	101	94	100	88
Value ---------------million dollars--	$4	$3	$4	$4	$4
Vitrified clay and sewer pipe fittings:					
Quantity ---------------thousand short tons--	1,721	1,718	1,647	1,454	1,190
Value ---------------million dollars--	$133	$143	$138	$134	$124
Unglazed, salt glazed and ceramic glazed structural facing tile, including glazed brick:					
Quantity ---------------million equivalent--	153	131	122	97	79
Value ---------------million dollars--	$15	$13	$13	$13	$11
Clay floor and wall tile, including quarry tile:					
Quantity ---------------million square feet--	276	308	301	273	236
Value ---------------million dollars--	$143	$159	$168	$168	$159
Total value [1] ---------------do----	$642	$722	$773	$695	$656

[1] Data may not add to totals shown because of independent rounding.

Table 22.—Common clay and shale used in building brick production in the United States in 1975, by State

State	Short tons	Value	State	Short tons	Value
Alabama	805,018	$1,112,036	Nebraska	88,504	$221,586
Arizona, Hawaii, Idaho	53,971	78,353	New Jersey	50,000	250,000
Arkansas	534,174	535,227	New Mexico and North Dakota	74,949	92,191
California	378,821	727,091	New York	158,803	313,020
Colorado	253,713	626,050	North Carolina	1,960,467	3,026,648
Connecticut	109,877	293,695	Ohio	1,164,032	2,781,367
Delaware	9,396	5,638	Oklahoma	375,380	670,767
Florida	7,829	11,301	Oregon	26,587	44,096
Georgia	1,398,916	2,810,000	Pennsylvania	895,278	2,638,838
Illinois	271,373	717,879	South Carolina	766,453	1,754,343
Indiana	363,207	618,706	South Dakota	11,000	14,300
Iowa and Maine	237,457	367,794	Tennessee	480,172	601,777
Kansas	522,761	548,608	Texas	1,282,768	2,792,280
Kentucky	282,309	381,489	Utah and West Virginia	183,941	340,787
Louisiana	150,103	249,134	Virginia	721,820	1,005,534
Maryland and Michigan	330,128	1,015,389	Washington	147,748	320,753
Massachusetts and Minnesota	109,162	184,025	Wisconsin	2,400	4,416
Mississippi	934,576	1,660,900	Wyoming	47,502	198,720
Missouri	160,891	411,997			
Montana and New Hampshire	48,219	83,775	Total	15,399,705	29,510,510

Table 23.—Clay and shale used in lightweight aggregate production in the United States in 1975, by State and kind

State	Short tons					Total value
	Concrete block	Structural concrete	Highway surfacing	Other	Total	
Alabama and Arkansas	835,849	165,405	--	5,000	1,006,254	$1,092,253
California	372,660	366,651	--	178,205	917,516	2,283,178
Colorado, Florida, Georgia	257,244	164,178	--	135	421,557	734,672
Illinois, Indiana, Iowa	932,974	330,566	--	--	1,263,540	2,517,075
Kansas, Kentucky, Louisiana	367,531	89,165	65,259	26,225	548,180	1,014,230
Maryland, Massachusetts, Minnesota	366,298	32,251	--	27,536	426,085	744,819
Mississippi	176,359	14,874	21,248	--	212,481	291,100
Missouri, Nebraska, North Carolina	280,635	183,515	--	--	464,150	809,700
Montana	19,076	--	--	--	19,076	35,400
New York	176,700	299,300	3,000	--	479,000	958,000
North Dakota, Ohio, Pennsylvania	191,189	28,742	--	--	219,931	366,550
Oklahoma	122,475	81,651	--	--	204,126	357,300
Oregon	18,000	12,000	--	--	30,000	70,000
South Dakota, Utah, Washington	130,621	33,879	--	--	164,500	330,390
Tennessee	194,736	10,200	--	--	204,936	320,660
Texas	531,728	151,589	711,002	67,680	1,461,999	2,203,835
Virginia	87,611	3,876	--	4,071	95,558	143,300
Total	5,061,686	1,967,842	800,509	308,852	8,138,889	14,272,462

Table 24.—Shipments of refractories in the United States, by kind

Product	Unit of quantity	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
CLAY REFRACTORIES					
Superduty fire clay brick and shapes	1,000 9-inch equivalent	77,771	$35,019	63,945	$37,732
Other fire clay, including semisilica, brick and shapes, glasshouse pots, tank blocks, feeder parts and upper structure parts used only for glass tanks	----do------	252,546	69,707	201,667	72,521
High-alumina (50%–60% Al_2O_3) brick and shapes made of calcined diaspore or bauxite [1]	----do------	93,799	81,552	70,683	78,152
Insulating firebrick and shapes	----do------	59,468	22,825	56,662	26,658
Ladle brick	----do------	234,099	43,232	174,580	36,311
Sleeves, nozzles, runner brick, tuyeres	----do------	51,338	23,738	36,048	19,858
Hot-top refractories	Short tons	31,971	2,918	19,132	2,167
Kiln furniture, radiant heater elements, potter's supplies, and other miscellaneous-shaped refractory items	----do------	NA	13,140	NA	13,784
Refractory bonding mortars	----do------	122,922	19,079	105,126	18,646
Plastic refractories and ramming mixes, containing up to 87.5% Al_2O_3 [2]	----do------	230109	r 31,685	200,155	33,042
Castable refractories	----do------	r 299,782	r 49,684	263,103	51,294
Gunning mixes	----do------	r 19,533	r 2,985	20,995	3,652
Other clay refractory materials sold in lump or ground form [3,4]	----do------	r 386,282	r 14,589	340,572	16,062
Total clay refractories		XX	r 410,153	XX	409,879
NONCLAY REFRACTORIES					
Silica brick and shapes	1,000 9-inch equivalent	37,626	20,004	37,478	29,376
Magnesite and magnesite-chrome brick and shapes	----do------	117,209	178,840	79,245	152,060
Chrome and chrome magnesite brick and shapes	----do------	20,726	30,536	13,890	25,148
Shaped refractories containing natural graphite	Short tons	22,561	23,863	19,196	21,752
Other carbon refractories: Forsterite, pyrophyllite, dolomite, dolomite-magnesite, molten-cast [5] and other brick and shapes	1,000 9-inch equivalent	40,418	97,085	21,759	64,710
Other mullite, kyanite, sillimanite, or andalusite brick and shapes	----do------	6,239	14,253	4,273	12,642
Other extra-high (over 60%) alumina brick and fused bauxite, fused alumina, dense-sintered alumina shapes [6]	----do------	4,148	16,475	3,738	20,142
Silicon carbide brick, shape, kiln furniture	----do------	5,272	25,644	4,522	24,975
Zircon and zirconia brick and shapes	----do------	2,703	11,380	2,121	16,736
Refractory bonding mortar	Short tons	60,250	12,245	37,190	9,182
Hydraulic-setting nonclay refractory castables	----do------	47,403	14,656	40,071	16,329
Plastic refractories and ramming mixes	----do------	233,833	48,737	171,648	43,732
Gunning mixes	----do------	422,104	55,624	311,366	53,510
Dead-burned magnesia or magnesite [3,7]	----do------	r 330,490	r 38,342	551,108	85,211
Other nonclay refractory material sold in lump or ground form [3]	----do------	473,006	18,277	432,265	20,359
Total nonclay refractories		XX	r 605,961	XX	595,864
Grand total refractories		XX	r 1,016,114	XX	1,005,743

r Revised. NA Not available. XX Not applicable.

[1] Heated short of fusion; volatile materials thus being driven off in the presence of chemical changes, giving more stable material for refractory use.

[2] More or less plastic brick and materials which after the addition of any water needed, are rammed into place.

[3] Materials for domestic use as finished refractories, and all exported material.

[4] Including calcined clay, ground brick and siliceous and other gunning mixes.

[5] Molten cast refractories are made by fusing refractory oxides and pouring the molten material into molds to form finished shapes.

[6] Completely melted and cooled, then crushed and graded for use in a refractory.

[7] Includes shipments to refractory producers for reprocessing in the manufacture of other refractories.

Table 25.—U.S. exports of clay by country and class in 1975

(Thousand short tons and thousand dollars)

Country	Bentonite		Fire clay		Fuller's earth		Kaolin		Ball clay		Clays, n.e.c.		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	1	138	(1)	4	--	--	6	549	--	--	4	289	11	980
Australia	58	1,010	1	93	(1)	21	10	442	--	--	11	1,019	80	2,585
Austria	--	--	--	--	(1)	5	1	44	--	--	9	876	10	925
Belgium-Luxembourg	1	89	2	44	4	283	1	54	--	--	1	136	9	606
Brazil	8	494	1	38	(1)	43	96	493	1	41	8	651	114	1,760
Canada	305	7,536	99	2,510	10	478	142	5,381	90	1,996	122	4,508	768	22,409
France	9	874	1	53	1	98	18	681	--	--	22	1,395	51	3,101
Germany, West	28	1,185	7	275	2	202	150	9,234	(1)	1	14	1,057	201	11,954
Guatemala	3	206	1	13	(1)	59	(1)	18	--	--	1	82	5	378
Iran	3	538	--	--	(1)	1	--	--	(1)	3	4	243	7	785
Italy	8	299	1	115	1	43	90	6,015	(1)	2	8	617	108	7,091
Japan	22	12,132	6	274	--	--	245	16,530	2	72	35	2,394	310	31,402
Korea, Republic of	(1)	144	1	58	(1)	1	6	598	--	--	1	150	8	951
Mexico	1	53	87	2,969	(1)	7	31	2,079	60	1,162	8	264	187	6,534
Netherlands	30	926	(1)	24	5	204	15	1,049	--	--	21	1,434	71	3,637
Peru	54	1,457	(1)	9	(1)	7	2	181	--	--	2	222	58	1,876
Philippines	1	168	3	127	(1)	55	1	62	2	90	3	425	10	927
Saudi Arabia	22	1,899	1	47	--	--	(1)	1	--	--	(1)	8	23	1,955
Singapore	23	1,639	1	6	1	60	(1)	15	--	--	1	52	26	1,772
South Africa, Republic of	2	382	(1)	1	(1)	8	3	407	(1)	7	3	217	8	1,022
Spain	6	224	(1)	35	(1)	2	6	374	--	--	5	477	17	1,112
Sweden	(1)	50	(1)	7	(1)	4	5	284	(1)	4	3	196	8	545
Taiwan	2	169	1	73	--	--	7	494	--	--	13	853	23	1,589
United Arab Emirates	12	947	--	--	1	136	--	--	--	--	--	--	13	1,083
United Kingdom	48	2,978	6	150	11	556	19	974	(1)	2	6	450	90	5,110
Venezuela	9	410	(1)	42	(1)	37	15	962	1	33	2	155	27	1,639
Other	41	3,504	(1)	224	6	527	11	984	(1)	64	14	1,267	72	6,570
Total	697	39,451	219	7,191	42	2,837	880	47,905	156	3,477	321	19,437	2,315	120,298

[1] Less than ½ unit.

Table 26.—U.S. imports for consumption of clay in 1975

Kind	Quantity (short tons)	Value (thousands)
China clay or kaolin, whether or not beneficiated:		
Canada	717	$46
Germany, West	45	(1)
Japan	22	7
Netherlands	58	4
United Kingdom	18,284	716
Total	19,126	773
Fuller's earth:		
Not beneficiated: United Kingdom	45	4
Wholly or partly beneficiated: United Kingdom	20	2
Bentonite:		
Canada	2,285	162
Germany, West	1	2
Italy	70	6
Total	2,356	170
Common blue and other ball clay:		
Not beneficiated:		
Canada	1	(1)
United Kingdom	9,395	242
Total	9,396	242
Wholly or partly beneficiated: United Kingdom	2,507	124
Clays, n.e.c.:		
Not beneficiated:		
Argentina	62	7
France	3	1
Total	65	8
Wholly or partly beneficiated:		
Canada	17	2
Germany, West	210	30
United Kingdom	1,389	145
Total	1,616	177
Clays artificially activated with acid:		
Canada	971	58
Germany, West	71	29
Italy	26	2
Japan	913	279
Mexico	882	79
Total	2,863	447
Grand total	37,994	1,947

[1] Less than ½ unit.

WORLD REVIEW

Australia.—Preliminary investigations of reportedly high-grade kaolin deposits were reported by Western Titanium Ltd.[6] In another kaolin development, the English China Clays Co. (ECC) announced that its new filler plant in the Melbourne area was operating successfully at full capacity.[7] To date, coating-grade kaolin was not produced in Australia.

Bolivia.—An unspecified halloysite deposit was being evaluated for potential use in manufacturing refractory bricks and ceramics.

Brazil.—The J. M. Huber Corp. (JMH) formed a joint venture, Caulim Do Para, with Construtora Mendes Junior S.A. (5%) to beneficiate Huber's large, high-quality kaolin deposits in the State of Pará. A processing plant, similar to JMH plants in Georgia, with an initial capacity of 280,000 tons per year of paper coating and filler clays was contemplated.[8]

Bulgaria.—Kaiser Engineers International Inc. was retained by the Ministry of Mineral Resources to work on technical and economic studies designed to evaluate indigenous oil shales and nonbauxitic resources for a possible alumina-aluminum industry in Bulgaria.[9]

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[6] Engineering and Mining Journal. This Month In Asia. V. 176, No. 9, September 1975, p. 236.
[7] Murray, H. H. Kaolin. Min. Eng., v. 28, No. 3, March 1976, pp. 38–39.
[8] Industrial Minerals. No. 97, October 1975, p. 11.
[9] Engineering and Mining Journal. Outlook–Oil Shale and Aluminum Development Sought by Bulgaria. V. 176, No. 1, January 1975, p. 9.

Burundi.—The United Nations Industrial Development Organization (UNIDO) sanctioned building an insecticide plant that would use kaolin mined in the Kayanza region, about 50 miles from Bujumbura, as a carrier.[10] Half of the plant's annual capacity, 2,225 tons of pesticide, was designated for the neighboring countries, Rwanda and Zaire, to protect their coffee and cotton plantations.

Canada.—Employees of the Canadian Refractory Division of Dresser Industries Canada Ltd. purchased their company's refractories, construction, and building brick businesses in British Columbia. The employees planned to operate under the name Clayburn Refractories Ltd.[11] General Refractories' Smithfield magnesite and chrome refractory brick plant in Ontario was planning a new manufacturing facility for high-alumina firebricks and bulk products.[12] Thunder Brick Co. awarded a contract to The Lingl Corp. to build a combined face brick and tile plant on the site of the former Rosslyn Brick Works in Thunder Bay, Ontario. Design capacity of the plant was 54,800 modular brick per day.[13]

France.—Pechiney Ugine Kuhlmann (PUK) concluded an agreement with Alcan Aluminum Ltd. to develop a sulfuric-hydrochloric acid process for recovering alumina from nonbauxitic raw materials, such as clays.[14]

Guyana.—A new brick plant, located on 30-acre site with accompanying mill buildings, was under construction in Georgetown.[15]

Indonesia.—The State tin-mining enterprise P. N. Timah continued exploration and testing on the tin islands Bangka, Belitung, Singkep, and Bangkinang, for new clay and kaolin deposits. Clays are currently being mined for the domestic ceramic industries by a number of small enterprises.[16]

Italy.—Production of activated bentonite at Sud-Chemie's new plant at Giba, Sardinia, after trial runs in 1974, was at its operating capacity of 100,000 to 120,000 tons per year.[17]

Pakistan.—An estimated 100 million tons of fire clay and 160,000 tons of china clay supply domestic industry and provide expansion potential. The china clay is used mostly in manufacturing ceramic products and the fire clay in firebricks.[18]

Saudi Arabia.—An $8.5 million contract was awarded to Swindell-Dressler Co., a division of Pullman, Inc., by the Saudi Red Brick Co. of Jiddah, to design, engineer, and supervise construction of a major ceramic building materials complex.[19]

South Africa, Republic of.—Recent changes in the structure and ownership of the G and W Group of companies have resulted in the emergence of Zimro (Pty.) Ltd. as a company owned by Anglo-American Corp. G and W was the country's largest producer of bentonite and kaolin.[20] The new company Zimro also includes Luzinada Umbeluzi Mina Lda., an important Mozambique bentonite producer. English Clays South Africa (Pty.) Ltd., a subsidiary of ECC, and recently installed in Pretoria, has acquired control of some local flint (fireclay) deposits.[21] The company was exploring the possibility of upgrading clays and related minerals for both local consumption and export. Plans were also announced for a pilot plant to produce chamotte (refractory grog and crude aggregates) for the refractories market.

Sweden.—Sala International AB, a member of the Boliden Group, and JMH have entered into an agreement under which Sala will act as exclusive licensing agent outside the United States for Huber's expertise on the application of magnetic separation to the beneficiation of clays and other related materials.[22]

Tanzania.—Plans were outlined for developing a kaolin industry to meet the re-

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[10] Industrial Minerals. No. 98, November 1975, p. 8.

[11] Industrial Minerals. No. 93, June 1975, p. 49.

[12] Industrial Minerals. No. 89, February 1975, p. 46.

[13] American Ceramic Society Bulletin. Thunder Bay Builds Brick and Tile Plant. V. 55, No. 4, April 1975, pp. 474–475.

[14] Mining Magazine (London). Highlights–International News: Europe–Pechiney Projects. V. 132, No. 1, January 1975, p. 63.

[15] Brick and Clay Record. Industry Newsfront–Guyana Building Large Brick Plant. V. 166, No. 5, May 1975, p. 13.

[16] U.S. Embassy, Jakarta, Indonesia. State Department Airgram A–90, June 1975, 13 pp.

[17] Industrial Minerals. No. 89, February 1975, pp. 34.

[18] U.S. Embassy, Islamabad, Pakistan. State Department Airgram A–70, Apr. 30, 1975, 4 pp.

[19] Industrial Minerals. No. 92, May 1975, p. 51.

[20] Industrial Minerals. No. 92, May 1975, p. 9.

[21] Mining Magazine. Briefly From Industry–English China Clays. V. 132, No. 1, January 1975, p. 73.

[22] Industrial Minerals. No. 92, May 1975, p. 51.

Table 27.—Kaolin: World production, by country

(Thousand short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Mexico	104	103	133
United States [2]	5,993	6,393	5,334
South America:			
Argentina	109	103	104
Brazil (beneficiated)	209	191	[e] 193
Chile	49	83	66
Colombia [e]	110	115	115
Ecuador	1	1	3
Paraguay	9	13	13
Peru [e]	1	1	1
Europe:			
Austria (marketable)	91	90	[e] 80
Belgium [e]	110	110	110
Bulgaria [e]	165	165	165
Czechoslovakia	496	534	580
Denmark [e]	20	20	20
France [3]	[e] 650	[e] 650	336
Germany, West (marketable)	538	546	[e] 550
Greece	84	91	80
Hungary	91	[e] 90	98
Italy:			
Crude	80	99	86
Kaolinitic earth	24	25	31
Poland	80	95	93
Portugal	49	55	57
Romania [e]	55	96	96
Spain (marketable) [4]	150	223	[e] 220
U.S.S.R. [e]	2,300	2,300	2,400
United Kingdom	3,758	3,858	[e] 3,900
Africa:			
Algeria	7	10	12
Angola	1	([5])	([5])
Egypt	33	28	[e] 30
Ethiopia (including Eritrea)	[e] 30	[e] 30	55
Kenya	1	1	1
Malagasy Republic	2	4	5
South Africa, Republic of	40	54	63
Swaziland	2	2	3
Tanzania	1	1	1
Asia:			
Bangladesh	7	1	4
Hong Kong	7	4	2
India:			
Salable	282	311	259
Processed	125	116	104
Indonesia	33	29	28
Iran [e]	83	110	110
Israel	11	5	13
Japan	440	456	227
Korea, Republic of	230	300	329
Malaysia	116	161	19
Pakistan	1	2	1
Sri Lanka	5	6	4
Taiwan [6]	23	[e] 23	[e] 23
Thailand	21	[e] 22	17
Turkey	26	28	24
Oceania:			
Australia	88	108	[e] 110
New Zealand	10	18	30
Total	[r] 16,951	17,880	16,338

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, the People's Republic of China, East Germany, Lebanon, Nigeria, South Vietnam, Southern Rhodesia and Yugoslavia also produced kaolin, but information is inadequate to make reliable estimates of output levels. Costa Rica, Guatemala, Morocco, and Mozambique each produced less than 500 tons in each of the years covered by this table.

[2] Kaolin sold or used by producers.

[3] Includes kaolinitic clay.

[4] Excludes unwashed kaolin as follows, in thousand short tons: 1973–84; 1974–84 (estimated); 1975–51.

[5] Less than ½ unit.

[6] Data given are for ceramic and pottery clays.

quirements of the domestic paper, glass, and ceramic industries.[23]

Turkey.—Plans for a plant in Kahramanras with an annual capacity of 20 million brick and 5 million tiles was reported by Martug Tugla Ve Kiremit A.S.[24]

United Kingdom.—The Canterbury-based Robert Brett group of companies applied for permission to work the calcium montmorillonite deposits at Baulking in Berkshire.[25] The Baulking deposit and the nearby deposit at Fernham were outlined by the Institute of Geological Sciences in the late sixties.

Hepworth Ceramic Holdings, Ltd., built two tunnel kilns with commissioning scheduled for 1976, and entered the European Market by purchasing an unnamed Belgian company. Watts, Blake and Bearne and Co., Ltd., which has china and ball clay operations, mainly in Devon, completed its new ball clay processing plant. The plant became fully operational during the year with a record of over 500,000 tons of ball clay.[26] ECC commissioned a new refining, drying, and calcining plant in Cornwall.[27]

Yugoslavia.—Current expansion of the Karacevo kaolin mine near Kosovska Kamenica, when completed by 1978, should increase production capacity to 70,000 tons per year. Reserves of the deposit were 3.5 million tons.

[23] U.S. Embassy, Dar Es Salaam, Tanzania. State Department Airgram A-065, Apr. 28, 1975, 5 pp.
[24] Industrial Minerals. No. 93, June 1975, p. 43.
[25] Industrial Minerals. No. 92, May 1975, pp. 9, 12.
[26] Industrial Minerals. No. 93, June 1975, p. 15.
[27] Industrial Minerals. No. 90, March 1975, pp. 10–11.

Table 28.—Bentonite: World production, by country
(Short tons)

Country [1]	1973	1974	1975 p
North America:			
Guatemala	--	2	e 10
Mexico	50,478	67,445	35,833
United States	3,072,542	3,310,500	3,229,267
South America:			
Argentina	112,048	124,806	127,870
Brazil	48,777	85,008	e 84,500
Colombia	r 1,320	1,100	e 1,100
Peru e	r 6,200	r 6,200	6,200
Europe:			
France e	r 15,400	r 15,400	15,400
Greece	520,543	423,737	e 420,000
Hungary	80,470	r e 80,000	96,890
Italy	329,974	379,089	308,691
Poland e	55,000	55,000	55,000
Romania e	55,000	69,200	70,000
Spain	52,502	83,684	e 88,200
Africa:			
Algeria (bentonite clay)	24,802	e 24,800	e 24,800
Morocco	6,315	3,652	3,363
Mozambique	2,660	r e 4,400	e 2,000
South Africa, Republic of	27,646	41,671	41,391
Asia:			
Burma	927	560	1,008
Cyprus (bentonite clays [2])	9,794	5,040	12,690
Iran	r 38,600	r 55,100	55,100
Israel (metabentonite)	4,400	4,190	3,300
Pakistan	1,069	1,010	e 620
Philippines	--	--	729
Turkey	r 8,609	14,793	43,832
Oceania:			
Australia [3]	991	885	880
New Zealand (processed)	1,136	1,206	[4] 5,783
Total	4,527,203	4,858,478	4,734,457

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed, Austria, Canada, the People's Republic of China, West Germany, Japan and the U.S.S.R. are believed to have produced bentonite, but output is not reported and available information is inadequate to make reliable estimates of output levels.
[2] Exports.
[3] Including bentonitic clay.
[4] Includes unprocessed bentonite.

Table 29.—Fuller's earth: World production of market economy countries, by country

(Short tons)

Country [1]	1973	1974	1975 [p]
Algeria [e]	66,000	66,000	66,000
Argentina	394	238	260
Australia	33	86	[e] 90
Italy	125,225	116,073	77,700
Mexico	55,449	59,372	42,105
Morocco (smectite)	21,078	22,150	26,147
Pakistan	12,505	17,216	[e] 13,200
Senegal (attapulgite)	8,349	10,774	18,407
South Africa, Republic of	1,010	(2)	--
United Kingdom	203,930	182,980	[e] 187,400
United States	1,138,433	1,224,640	1,189,064
Total	[r] 1,632,406	1,699,529	1,620,373

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, France, Iran, Japan, and Turkey have reportedly produced fuller's earth in the past and may continue to do so, but output is not reported and available information is inadequate to make reliable estimates of output levels. Similarly, no information is available on output in the centrally planned economy countries of Europe and Asia, but at least some of them also are presumably producing fuller's earth.

[2] Revised to zero.

TECHNOLOGY

The Federal Bureau of Mines and nine companies (one more than in 1974)—eight aluminum producers and a refractory manufacturer—continued cosponsoring research on extracting alumina from domestic materials that are plentiful, which could ease our dependence on imported metallurgical- and refractory-grade bauxite. Using minipilot-plant facilities at the Boulder City (Nevada) Metallurgy Laboratory, researchers were investigating several methods for extracting alumina from clays, anorthosite, alunite, and dawsonite-bearing oil shales. Each participating company was contributing $50,000 annually, with the cost to the Bureau in excess of $500,000 annually.

The clay/nitric acid miniplant, the first acid process studied, using calcined kaolin was successfully completed and placed on a standby basis. Only minor laboratory wrapup efforts were being conducted on this process. The miniplant study showed that with four stages of countercurrent decantation, over 90% of the alumina was recoverable. Current work was being devoted to the design, construction, and operation of a kaolin clay/hydrochloric acid miniplant. This miniplant has already been operated for three integrated campaigns, each time with more of the equipment in place. Preliminary data show recoveries of 95% of the acid-soluble alumina during leaching. The complex problem of $AlCl_3 \cdot 6H_2O$ crystallization was responding favorably to HCl gas sparging; chloride decomposition to alumina, another problem area, was amenable to a roasting technique. A lime-sinter process to recover alumina from anorthosite was derived from the literature. The process features sintering finely ground and thoroughly mixed anorthosite and limestone to produce a self-disintegrating (dusting of δ-dicalcium silicate) mixture of dicalcium silicates and calcium aluminates. The alumina is leached from the mixture with sodium carbonate solutions and the alumina precipitated by carbonation. Equipment flowsheets have been prepared with the equipment sized to produce 20 pounds of alumina per hour. Construction of the anorthosite miniplant was underway.

In another effort, the Bureau was exploring the feasibility of chlorinating clays and other domestic aluminiferous materials directly and for purifying this crude aluminum chloride to electrolytic grade. Current technology employs a high-purity anhydrous chloride in a fused-salt electrolytic cell. This Bureau purification research, if successful, would allow continuous removal of iron immediately prior to the electrolytic reduction to aluminum metal thereby permitting a wide variation in the iron contamination of the crude $AlCl_3$ feed.[28]

[28] U.S. Bureau of Mines. "Purification of Crude Aluminum Chloride By Fused-Salt Flutrolysis. Mineral Research and Data Analysis Highlights, v. 1, No. 9, May 1975, p. 6.

In related clay work, as a part of the Bureau's program to broaden utilization of abundant low-quality mineral material, beneficiation studies were conducted on two Alabama clays, an underclay and a kaolin. Results showed that by a combination of attrition grinding and sodium dithionite leaching to remove iron contamination, the underclay could be upgraded to a ball clay material. The kaolin, cone 04 or 1,050° C whiteness of 89, responding favorably to a pH adjustment to approximately 9 by sodium carbonate addition, appeared to be an excellent ball clay substitute.[29]

Other alternative methods of producing alumina from clays were patented during the year. In one patent, the finely divided ore is digested in hot concentrated sulfuric acid and subsequently treated with aqueous hydrochloric acid to precipitate hydrated aluminum chloride.[30] The aluminum chloride is further processed to recover both alumina and liberate hydrochloric acid for recycling.

Another patent outlines a nitric acid method for recovering the alumina values from clays.[31] In this technique, the clays are leached to produce an impure aluminum nitrate solution, which is then contacted with an ion-exchange liquid to remove the iron and further treated to yield a cell-grade alumina. In another chloride-forming process, the claylike material is dehydrated, coked, and contacted at 700° to 1,000° C with a gaseous stream of chlorine and carbon monoxide to evolve aluminum trichloride suitable for use either in producing metal or chemicals by conventional means.[32] In a nonacid method patented, the clay or any other aluminosilicate is upgraded, agglomerated and reduced carbothermically in an electric furnace to produce an aluminum-silicon alloy, which is then separated, comminuted, and then hydroaluminized using an olefin, hydrogen, and a catalyst to recover a material that is eventually pyrolyzed to an aluminum powder.[33]

A review highlighted the past, present, and future of high-intensity, high-gradient wet magnetic separation (HGMS).[34] This review also traced the historical evolution of HGMS designs and depicted some of the currently available commercial separators. This work, while highlighting the removal of contaminants from mineral and chemical industries, also stressed its role in environmental protection and water purification. A comment on role of the kaolin industry in HGMS progress and the companies, which together have fabricated and installed most of large units, was advanced.[35]

The importance of organic-coated industrial minerals, such as bentonites and fuller's earths, and the many industries in the United Kingdom using these materials was reviewed.[36] The technology of property modification brought about by the coatings, and their applications in the paint, rubber, and plastic industries, in lubricants, in the fertilizer industry (as anticaking agents), were also discussed. A similar, but more detailed, work was published on the role of clays and other inorganic materials in paint manufacturing.[37]

The two techniques developed for using bentonite in making low-cost retaining walls was discussed.[38] One method used alternating piles of concrete and hardened bentonite to build a 33-foot-deep wall to cut off ground water. The other method suspended precast panels in the bentonite, then exposed them by excavating after the slurry was gelled with additives. An added advantage of these techniques is the absence of noise and vibration that accompanies the pile-driving methods.

A detailed discussion of the industrial mineral deposits of Wyoming, Utah, Idaho, and Montana was published.[39] The Wyom-

[29] Goode, A., and M. E. Tyrrell. Beneficiation of Alabama Clays. BuMines RI 8071, 1975, 7 pp.

[30] Assigned to Aluminum Pechiney. Acid Treatment of Ores. Brit. Pat. 1,394,703, May 21, 1975.

[31] Huska, P. A., and H. P. Meissner (assigned to Arthur D. Little Inc.). Method and Apparatus for Providing a Pure Concentrated Aqueous Solution of Aluminum Nitrate. Can. Pat. 970,531, July 8, 1975.

[32] Nemeca, E., A. Ujhidy, K. Polinsky, J. Szepvolgyi, O. Borlai, L. Kapolyi, and T. Szekely (assigned to Toth Aluminum Corp.). U.S. Pat. 3,937,786, Feb. 10, 1976.

[33] Assigned to Ethyl Corp. Aluminum Process. Brit. Pat. 1,415,475, Nov. 26, 1975.

[34] Kolm, H., J. Oberteuffer, and D. Kelland. High-Gradient Magnetic Separation. Sci. Am., v. 233, No. 5, November 1975, pp. 46–54.

[35] Iannicelli, J. Letters—Magnetic Separators in Kaolin. Eng. and Min. J., v. 176, No. 9, September 1975, p. 4.

[36] Jones, G. K. Organic-Coated Industrial Minerals in the U.K. Ind. Miner., No. 95, August 1975, pp. 39–43.

[37] Mayhew, L. D. Paint—1: Inorganic Materials in Paint Manufacture. Ind. Miner., No. 99, December 1975, pp. 17–36.

[38] Engineering News-Record. Gelled Bentonite Produces Low-Cost Retaining Walls. V. 196, No. 1, January 1976, p. 19.

[39] Industrial Minerals. North-West USA: Some Industrial Mineral Operations. No. 96, September 1975, pp. 15–44.

ing swelling bentonite deposits, the producers and their flowsheets, their markets, present and future, reclamation techniques, and outlook were singled for a comprehensive treatment. Another work discusses the Giba Sardinian bentonite deposits and presents a flowsheet showing sodium-exchange, drying, classifying, and grinding procedures.[40] A brief résumé of the materials in Manitoba, Canada, available for heavy-clay products, their properties, and products made from them were summarized along with a brief history of the area's clay industry.[41] A discussion of a flowsheet for producing filler-quality kaolin from the Ione deposit, its northwest paper mill markets, and transportation problems were outlined in a concise work.[42]

The adsorption of the water-soluble fraction of poultry litter was investigated using selected soils, kaolins, and bentonites, as adsorbants.[43] Results indicated that the litter was adsorbed similarly by either the soils or the clays, but the rate of adsorption was faster with bentonites. The application of these adsorbed clays with their organic matter as a soil amendment would go a long way in eliminating a sanitary disposal and/or pollution problem while providing a valuable source of plant nutrients. Another study directed toward using kaolins and montmorillonite clays to preferentially remove contaminating industrial dyes from textile discharge wastes was published.[44] Research revealed that both types of clays were effective in removing the objectionable dyes from the discharge waters.

A detailed discussion of modern refractory maintenance procedures for vertical and rotary lime kilns was highlighted.[45] The discussion included sections on refractory selection, availability, and support equipment required for relining. In addition, the forms of the commonly available refractories, brick, castables, plastic, ramming mixes, and mortar, and the analysis of service conditions in both types of kilns were also detailed. A process involving a very low heat requirement—only 1,200 Btu per pound for the entire fabrication—was outlined for producing expanded lightweight clay aggregates.[46]

[40] Industrial Minerals. Süd-Chemie's Sardinian Bentonite. No. 95, August 1975, pp. 34–35.

[41] Shoyna, M. Clays of Manitoba and Specific Clays Used By Red River Brick and Tile For Brick Products. Can. Min. and Met. Bull., v. 68, No. 761, September 1975, pp. 81–84.

[42] Pit and Quarry. Kaolin Corporation's Ione, Calif. Plant. V. 68, No. 3, September 1975, pp. 105–106.

[43] Tan, K. H., V. G. Mudgal, and R. A. Leonard. Adsorption of Poultry Litter Extracts By Soil and Clay. Environ. Sci. and Technol., v. 9, No. 2, February 1975, pp. 132–135.

[44] Sethuraman, V. V., and B. C. Kaymahashay. Color Removal by Clays—Kinetic Study of Adsorption of Cationic and Anionic Dyes. Environ. Sci. and Technol., v. 9, No. 13, December 1975, pp. 1139–1140.

[45] Peck, G. L. Refractory Maintenance—A "Must" for Better Lime Kiln Service. Rock Products, v. 78, No. 7, July 1975, pp. 71–73, 106.

[46] Ironman, R. Low Heat and Energy Requirements Extend Liapor System Use. Rock Products, v. 78, No. 2, February 1975, pp. 42–44.

Coal—Bituminous and Lignite

By L. W. Westerstrom [1] and R. E. Harris [2]

CONTENTS

DOMESTIC PRODUCTION

In 1975, production of bituminous coal and lignite reached an alltime high of 648.4 million tons, a 7.5% increase over the 603.4 million tons produced in 1974. The previous record production year was 1947 when production was 630.6 million tons. Despite the record output, bituminous coal and lignite consumption increased less than 4 million tons. Essentially all of the increase in production went into replenishing stockpiles which had been drawn upon heavily during the coal miners' strike in the fourth quarter of 1974, and to meet increased demands for export coal. The slowdown in the economy, particularly in the first half of 1975 resulted in only a nominal increase in electric utility coal consumption and a decline in coal requirements by steel companies.

In 1975, there were 6,168 bituminous coal and lignite mines operating in 26 States located in Appalachia, the Midwest, and the Mountain and Pacific regions. The leading coal producing States in order of output were Kentucky, West Virginia, Pennsylvania, Illinois, Ohio, and Virginia. Combined, they accounted for 74% of total U.S. production. Underground production increased about 16 million tons in 1975, while production from surface mines increased 30 million tons and accounted for 55% of total coal output.

The data in this chapter include all bituminous coal produced in the United States except that from mines producing

[1] Industry economist, Division of Coal.
[2] Mining engineer, Division of Fuels Data.

Table 1.—Salient statistics of the bituminous coal and lignite industry in the United States

Item	1971	1972	1973	1974	1975
Production ----------thousand short tons--	552,192	595,386	591,738	603,406	648,438
Value --------------------------thousands--	$3,904,562	$4,561,983	$5,049,612	$9,502,347	$12,472,486
Consumption ----------thousand short tons--	494,862	516,776	556,022	552,709	556,301
Stocks at yearend:					
Industrial consumers and retail yards do----	89,985	116,500	103,022	95,528	127,115
Stocks on upper lake docks ------do----	1,205	939	822	1,051	1,185
Exports [1] --------------------------do----	56,633	55,997	52,870	59,926	65,669
Imports [1] --------------------------do----	111	47	127	2,080	940
Price indicators, average per net ton:					
Cost of coking coal at merchant coke ovens --------------------------------	$15.26	$17.67	$19.77	$34.20	$52.63
Railroad freight charge [2] --------------	$3.70	$3.67	$3.71	$4.71	$5.23
Value f.o.b. mines (sold in open market)	$6.66	$7.35	$8.06	$15.16	$18.02
Value f.o.b. mines --------------------	$7.07	$7.66	$8.53	$15.75	$19.23
Method of mining:					
Hand-loaded underground thousand short tons--	4,992	2,974	1,970	710	508
Mechanically loaded underground -do----	270,896	301,129	297,384	276,599	292,317
Percentage mechanically loaded --------	98.2	99.0	99.3	99.7	99.8
Percentage cut by machine ------------	40.6	37.4	35.8	33.0	32.0
Mined by surface --thousand short tons--	276,304	291,284	292,384	326,097	355,612
Percentage mined by surface ----------	50.0	48.9	49.5	54.0	54.8
Mechanically cleaned --thousand short tons--	271,401	292,829	288,918	265,150	266,993
Percentage mechanically cleaned -----------	49.1	49.2	48.8	43.9	41.2
Number of mines -------------------------	5,149	4,879	4,744	5,247	6,168
Capacity at 235 days --thousand short tons--	618,000	622,000	613,000	653,458	656,823
Average number of men working daily:					
Underground mines ------------------	109,311	112,252	111,083	119,416	134,710
Surface mines -----------------------	36,353	37,013	37,038	47,285	55,170
Total --------------------------------	145,664	149,265	148,121	166,701	189,880
Average number of days worked:					
Underground mines ------------------	210	222	231	205	228
Surface mines -----------------------	212	217	215	208	241
Total --------------------------------	210	221	227	206	232
Production per man per day:					
Underground mines --------short tons--	12.03	11.91	11.66	11.31	9.54
Surface mines -----------------do----	35.88	36.33	36.67	33.16	26.69
Total -------------------------do----	18.02	17.74	17.58	17.58	14.74

[1] Bureau of the Census, U.S. Department of Commerce.
[2] Interstate Commerce Commission.

less than 1,000 tons per year. All quantity figures represent net tons of marketable coal and excludes washery and other refuse. Statistics are final and based upon detailed annual reports of production and mine operation furnished by producers. For production not directly reported (chiefly that of small mines), data were obtained from the records of State mine departments, which have statutory authority to require such reports. Thus, complete coverage of all mines producing 1,000 tons a year or more is reported.

The weekly and monthly estimates of production, summarized in tables 6–7, are based upon railroad carloadings of coal reported weekly by railroads, river shipments reported by the U.S. Army Corps of Engineers, reports from mining companies, and monthly production statements compiled by local operators associations and State mine departments.

There were approximately 23,000 more men mining bituminous coal and lignite in 1975 compared with 1974. The total number of production workers increased from 167,000 to nearly 190,000. Productivity at surface mines declined from 33.16 tons per man per day to 26.69 tons per man per day. The average productivity at all mines declined from 17.58 tons per man per day in 1974 to 14.74 tons in 1975.

CONSUMPTION AND DISTRIBUTION

Tables 42–45 summarize shipments of coal and lignite in 1975. Table 45 shows the quantitative changes in total tons by geographic division and States of destination from 1971 through 1975. The distribution data by consumer use does not necessarily conform to the consumption data because the latter represents actual use at consumer's facilities, whereas the distribution data represented shipments from the mines, some of which were in transit or in consumers' storage. These distribution data are based on reports submitted quarterly to the Bureau of Mines by producers, sales agents, distributors, and wholesalers, who normally produce or sell 100,000 tons or more annually. Their reported tonnage accounted for 93% of coal shipments, estimates for the remaining shipments, are included, based on data from the Federal Power Commission and other reliable coal statistical reporting agencies. Additional details of bituminous coal and lignite distribution are presented in a Bureau of Mines report.[3]

PRICES

The average mine price of bituminous coal and lignite increased from $15.75 per ton in 1974 to $19.23 per ton in 1975. The average price of coal produced at underground mines increased from $19.86 per ton to $26.28 per ton. The average price coal shipped from surface mines increased from $12.25 per ton to $13.44 per ton. The average rail freight charge on coal increased from $4.71 per ton in 1974 to $5.23 per ton in 1975.

FOREIGN TRADE

In 1975, the United States exported 65.7 million tons of bituminous coal, an increase of about 6 million tons compared with exports in 1974. Japan maintained its position as the principal U.S. foreign market with a 38.8% share of total U.S. coal exports. Shipments of coal to Canada, Europe, and South America accounted for 26.3%, 28.9% and 5.0% respectively.

TECHNOLOGY

In recent years, research has been primarily on improvement in coal mining methods and efficiency rather than innovation. In underground mining, current coal mining technology is characterized by a variety of specially designed mechanical cutting and loading devices, such as mobile loading machines, continuous-mining machines, and longwall equipment. Continuous-mining machines replaced the mobile loaders at many locations and in 1975, continuous-mining machines cut and loaded nearly two-thirds of total underground production.

The rapid rate of coal extraction by continuous mining makes it imperative that haulage be coordinated to the fullest extent possible with extraction and loading operations. Short supplemental belt conveyor systems, which move coal from continuous-mining machines to the main haulage system without shuttle cars, are being used extensively to approach this objective. Considerable improvements are still necessary in underground haulage if transportation systems are to keep pace with the high productivity of continuous-mining machines, which often have to halt operations while transportation facilities handle the coal already cut from the face.

Research on the best way to control respirable dust continued with the introduction in 1975 of several new collection and spray systems, foams, and wetting agents. New bits and cutting systems also promise to reduce dust production.

Two systems for determining the locations of miners trapped by cave-ins, fires,

[3] Bureau of Mines. Bituminous Coal and Lignite Distribution for Calendar Year 1975. Mineral Industry Surveys, Apr. 12, 1976, pp. 51.

or explosions were introduced. One was based on the detection on the surface of seismic vibrations caused by a miner hammering on a roof bolt. The system is limited to vertical distances of 700 to 800 feet, and up to a 1,000-foot horizontal distance. The other system comprises a small radio transmitter powered by a cap lamp battery, a transmitting antenna that the miner deploys in a circular pattern, a helicopter-mounted receiver that is flown in a controlled grid over the mine area, and ground receivers for locating the trapped men.

Underground lighting received considerable attention in 1975 in response to regulations proposed by the Mining Enforcement and Safety Administration (MESA). New lighting techniques were applied to cap lamps, machine-mounted lamps, and portable area lamps. Good results were obtained using incandescent, sodium, mercury-vapor, and fluorescent light sources. Principal problems included distribution wiring, voltage requirements, and startup and restart relays (for the sodium and mercury-vapor light sources). Probably the most significant problem, particularly with sodium and mercury-vapor lights, was to provide sufficient illumination while preventing glare or temporary blindness produced by either looking at the light source or walking out of the illuminated area.

In strip mining, the trend was towards larger equipment, particularly for overburden removal, loading, and haulage.

Haulage trucks continued to get bigger, more powerful, and more versatile. One of the more promising trends in off-highway coal-hauler design is the integration of the power and drive trains and the payload body into a single-unit chassis, in contrast with the conventional tractor-trailer design. Integrated units with a 150-ton payload capacity started operation in 1970, and 250- to 300-ton units were in design stages.

To negotiate slippery roads, difficult grades, and tight turns, all-wheel-drive haulage units are becoming increasingly popular. Articulated chassis were incorporated on some all-wheel-drive units to reduce tire wear.

Conveyor belts are becoming increasingly popular for transporting coal at many surface-mining operations. As annual tonnages and haulage distances increased, the overall installation and operating costs of conveyor belts became more favorable. Today some operators of surface mines are considering shiftable and portable conveyor systems in the pits, presently used at some European operations.

Tractor-scrapers continued to prove versatile at both production and reclamation operations, and are becoming quite prevalent at western and Appalachian mines for removing and stockpiling topsoil and other suitable materials for later replacement on graded mined lands. Some surface mines use tractor-scraper units as the primary means for overburden removal. As the use of units of this type increases, more efficient power trains and other improved design features are being introduced.

New designs of blades and attachments and more powerful engines were introduced during 1975 for bulldozers.

Bucket wheel excavators are proving to be a valuable reclamation tool. In the relatively flat land of the Midwest, bucket wheel excavators are used to remove topsoil and upper layers of overburden. Power shovels then remove the remaining drilled and blasted strata above the coalbed. In Illinois, these wheel-shovel combinations are utilized as often as draglines for primary overburden removal.

In Appalachia, new methods were used to meet surface mining regulations relating to highwalls and slopes. The haulback technique was highly successful in 1975 in West Virginia, where more than 20 surface mining companies used or were planning to use haulback techniques.

Although the haulback concept is not new, it had never been tried on long, steep slopes. The mining operation requires precise, controlled blasting (so that no material goes down the slope); the overburden is then hauled from the working site in trucks for the use as backfill in nearby worked-out areas. This technique reduced the amount of disturbed lands by up to two-thirds in many cases.

About 41% of the bituminous coal and lignite produced in 1975 was mechanically cleaned. Cleaning equipment consisted of a variety of jigs, tables, launderers, dense-medium and flotation washers, and pneumatic devices, but all depend upon the difference in specific gravity between coal and impurities, for separation. The specific cleaning method chosen depends on the size of coal to be upgraded, the composition of the raw product, and the chemical-quality specifications imposed by the consumer. In general, American coals are easy to clean except when the sulfur is structurally bound in the coal matrix as organic compounds, or is present as finely divided pyritic (inorganic) compounds. Some coal can be crushed to free coarse pyritic sulfur, but as the particle size becomes smaller, the problem of separation becomes more difficult and costly. The designs of coal preparation equipment are well advanced and commercially available.

Coal mining research is currently aimed at increasing the productivity and unit operating capacities of mining systems without adversely affecting safety or the environment. Toward this end, the Bureau of Mines has been conducting intensive, long-range coal mining and exploration research programs. Because of the geographic and stratigraphic distribution of coal resources, a continuing production mix from both surface and underground mining is needed. Accordingly, the near-term goal of the program is to develop technologies that will result in significant increases in production, productivity, and coal recovery with present surface and underground mining methods.

In the exploration program, emphasis is being placed on securing more definitive geologic and geochemical data on many coal deposits, particularly those in the Western States. Although coal reserves are adequately identified for short-term policy and production needs, extended data are needed to provide industry with better knowledge on which to base their regional mining extraction plans, and also to determine the environmental impact of mining.

The environmental studies will concentrate on developing criteria to measure the impact of mining on the ecosystem. Most of the research on environmental protection technology will be integrated with the research on new mining systems.

The major goals in the mining technology program are to (1) increase the production per shift from both conventional and continuous mining by increasing the reliability of existing equipment, (2) improve productivity substantially by the automation or remote control of as many operations as possible, (3) accelerate the use of longwall mining to increase the percentage of coal recovered and mine more efficiently and safely coal deposits at greater depths and under difficult strata conditions, (4) recover methane from the coalbed prior to mining to speed production by eliminating methane problems and to utilize the methane, (5) develop mining systems that can economically recover 80% or more of thick and steeply pitching seams of coal in certain western deposits, (6) develop the technology to provide adequate protection of the surface environment from underground mining such as subsidence and water contamination, and (7) to reduce the time required to develop new mines and bring them to full production.

The major goal of the Bureau of Mines for advancing technology in surface mining is directed toward integrating excavation and reclamation to reduce the environmental impact. Equipment will be developed where specialized needs are identified that would improve the efficiency of mining and restoring the surface. The Bureau is trying to improve efficiencies of large stripping equipment by automating the dig-haul-dump-spread cycle. Reclamation techniques are being developed that will be particularly adaptable to the arid and semiarid western coal regions.

In coal preparation practices, the design features of units using gravity separation are fairly well established. There will be improvements in design and operating features permitting better separation methods, including greater reduction of pyritic sulfur. The demands of the metallurgical market will impose increasingly stringent requirements on grades of coal, especially in regard to sulfur content. Similarly, electric utilities, which constitute coal's major growth area, are being required to burn low-sulfur coals until air pollution regulations are met by either the reduction of sulfur content in coals or through the development of processes for the removal of sulfurous pollutants from flue gases. Some of the processes being developed by the private industry appear to be nearing technical feasibility.

Although coal is used primarily as a fuel to generate heat and power, considerable research is underway to develop new uses. Among the new processes in various stages of research or development are those dealing with the production of carbon black from coal, the synthesis of foodstuffs, the treatment of sewage and organic wastes with coal, and conversion of coal to synthetic gas and liquid fuels.

The production of gaseous and liquid fuels from coal is not economically feasible at the present time in the United States. Research is underway, however, to reduce conversion costs by improving process technology. Probably two of the greatest technical drawbacks in converting coal to high-Btu gaseous or liquid fuels is the large volume of costly hydrogen required and the performance of the catalyst in the methanization step of the process. To overcome the hydrogen deficiency, many methods have been studied for producing low-cost hydrogen. Other conversion research includes developing processes that produce a char and a liquid fuel, and improving catalysts used in both liquid and gas conversion processes. Large-scale commercial conversion of coal to gaseous and liquid fuels will depend on many variables in addition to technology, such as the rate of new oil and gas discoveries, oil import policy, the price of indigenous oil and gas supplies, and the progress made toward using oil shale.

Table 2.—Demonstrated coal reserve base of the United States on January 1, 1974, by underground method of mining

(Million tons)

State	Sulfur range, percent				
	<1.0	1.1–3.0	>3.0	Unknown	Total [1]
Alabama	589.3	1,016.7	14.8	176.2	1,798.1
Alaska	4,080.8	163.2	--	--	4,246.4
Arkansas	43.3	310.3	29.2	19.1	402.4
Colorado	6,751.3	640.0	47.3	6,547.3	13,999.2
Georgia	.3	--	--	.2	.5
Illinois	1,034.7	5,848.4	33,647.6	12,908.4	53,441.9
Indiana	443.5	2,746.6	4,355.1	1,402.5	8,948.5
Iowa	1.5	226.7	2,105.9	549.2	2,884.9
Kentucky, East	5,042.7	2,391.9	212.7	1,814.0	9,466.5
Kentucky, West	--	386.6	7,226.4	1,107.1	8,719.9
Maryland	106.5	623.9	171.2	--	901.9
Michigan	4.6	84.9	20.8	7.0	117.6
Missouri	--	134.2	3,590.2	2,350.5	6,073.6
Montana	63,464.2	1,939.8	456.2	--	65,834.3
New Mexico	1,894.3	214.1	.9	27.5	2,136.5
North Carolina	--	--	--	31.3	31.3
Ohio	115.5	5,449.9	10,109.4	1,754.1	17,423.3
Oklahoma	154.5	238.5	202.6	264.3	860.1
Oregon	1.0	--	--	--	1.0
Pennsylvania	7,179.7	16,195.2	3,568.1	2,864.8	29,819.2
Tennessee	139.3	370.0	101.4	53.9	667.1
Utah	1,916.2	1,397.6	6.8	460.3	3,780.5
Virginia	1,728.5	945.4	12.0	283.3	2,970.7
Washington	431.0	957.8	13.2	42.9	1,445.9
West Virginia	11,086.6	12,583.4	6,552.9	4,142.9	34,377.8
Wyoming	20,719.5	4,535.1	1,275.6	2,955.0	29,490.8
Total [1]	126,928.8	59,400.2	73,720.2	39,761.6	299,839.7

[1] Data may not add to totals shown because of independent rounding.

Table 3.—Demonstrated coal reserve base of the United States on January 1, 1974, by surface method of mining

(Million tons)

State	Sulfur range, percent				
	<1.0	1.1–3.0	>3.0	Unknown	Total [1]
Alabama	35.4	83.2	1.6	1,063.2	1,183.7
Alaska	7,377.6	21.0	--	--	7,399.0
Arizona	173.3	176.7	--	--	350.0
Arkansas	37.9	152.8	17.1	55.2	263.3
Colorado	724.2	146.2	--	--	870.0
Georgia	--	--	--	(2)	--
Illinois	60.4	1,493.0	9,321.3	1,347.8	12,222.9
Indiana	105.3	559.2	907.3	101.6	1,674.1
Iowa	--	--	--	(2)	--
Kansas	--	309.2	695.6	383.2	1,388.1
Kentucky, East	1,515.7	929.9	86.8	915.3	3,450.2
Kentucky, West	.2	177.8	2,017.5	1,708.8	3,904.0
Maryland	28.6	66.6	16.2	34.6	146.3
Michigan	--	.5	.1	--	.6
Missouri	--	47.8	1,635.8	1,730.0	3,413.7
Montana	38,182.4	2,175.2	46.4	2,166.7	42,561.9
New Mexico	1,681.0	579.3	--	--	2,258.3
North Carolina	--	--	--	.4	.4
North Dakota	5,389.0	10,325.4	268.7	15.0	16,003.0
Ohio	18.9	991.0	2,524.9	117.9	3,653.9
Oklahoma	120.5	88.1	38.8	186.2	434.1
Oregon	.5	.3	--	--	.8
Pennsylvania	138.6	718.4	231.5	89.5	1,181.4
South Dakota	103.1	287.9	35.9	1.0	428.0
Tennessee	65.5	163.2	55.2	34.1	319.6
Texas	659.8	1,884.6	284.1	444.0	3,271.9
Utah	52.3	149.1	42.6	18.0	262.0
Virginia	411.6	218.1	2.1	46.7	679.2
Washington	172.5	307.7	25.8	2.2	508.1
West Virginia	3,005.5	1,422.8	270.4	509.6	5,212.0
Wyoming	13,192.8	10,122.3	425.5	105.3	23,845.3
Total [1]	73,252.3	33,597.4	18,950.9	11,076.1	136,885.7

[1] Data may not add to totals shown because of independent rounding.
[2] Undetermined.

Table 4.—Demonstrated coal reserve base of the United States on January 1, 1974, total underground and surface

(Million tons)

State	Sulfur range, percent				
	<1.0	1.1–3.0	>3.0	Unknown	Total [1]
Alabama	624.7	1,099.9	16.4	1,239.4	2,981.8
Alaska	11,458.4	184.2	--	--	11,645.4
Arizona	173.3	176.7	--	--	350.0
Arkansas	81.2	463.1	46.3	74.3	665.7
Colorado	7,475.5	786.2	47.3	6,547.3	14,869.2
Georgia	.3	--	--	.2	.5
Illinois	1,095.1	7,341.4	42,968.9	14,256.2	65,664.8
Indiana	548.8	3,305.8	5,262.4	1,504.1	10,622.6
Iowa	1.5	226.7	2,105.9	549.2	2,884.9
Kansas	--	309.2	695.6	383.2	1,388.1
Kentucky, East	6,558.4	3,321.8	299.5	2,729.3	12,916.7
Kentucky, West	.2	564.4	9,243.9	2,815.9	12,623.9
Maryland	135.1	690.5	187.4	34.6	1,048.2
Michigan	4.6	85.4	20.9	7.0	118.2
Missouri	--	182.0	5,226.0	4,080.5	9,487.3
Montana	101,646.6	4,115.0	502.6	2,166.7	108,396.2
New Mexico	3,575.3	793.4	.9	27.5	4,394.8
North Carolina	--	--	--	31.7	31.7
North Dakota	5,389.0	10,325.4	268.7	15.0	16,003.0
Ohio	134.4	6,440.9	12,634.3	1,872.0	21,077.2
Oklahoma	275.0	326.6	241.4	450.5	1,294.2
Oregon	1.5	.3	--	--	1.8
Pennsylvania	7,318.3	16,913.6	3,799.6	2,954.2	31,000.6
South Dakota	103.1	287.9	35.9	1.0	428.0
Tennessee	204.8	533.2	156.6	88.0	986.7
Texas	659.8	1,884.6	284.1	444.0	3,271.9
Utah	1,968.5	1,546.7	49.4	478.3	4,042.5
Virginia	2,140.1	1,163.5	14.1	330.0	3,649.9
Washington	603.5	1,265.5	39.0	45.1	1,954.0
West Virginia	14,092.1	14,006.2	6,823.3	4,652.5	39,589.8
Wyoming	33,912.3	14,657.4	1,701.1	3,060.3	53,336.1
Total [1]	200,181.1	92,997.6	92,671.1	50,837.7	436,725.4

[1] Data may not add to totals shown because of independent rounding.

Table 5.—Annual average unit heat value of bituminous coal and lignite produced and consumed in the United States, 1955–75 [1]

Year	Total production			Domestic consumption		
	Thousand short tons	Trillion Btu	Average Btu per pound	Thousand short tons	Trillion Btu	Average Btu per pound
1955	464,633	12,080	13,000	423,412	10,940	12,290
1956	500,874	13,013	12,990	432,858	11,142	12,870
1957	492,704	12,800	12,990	413,668	10,640	12,860
1958	410,446	10,663	12,990	366,703	9,366	12,770
1959	412,028	10,581	12,840	366,256	9,332	12,740
1960	415,512	10,662	12,830	380,429	9,693	12,740
1961	402,977	10,308	12,790	374,405	9,502	12,690
1962	422,149	10,782	12,790	387,774	9,826	12,670
1963	458,928	11,712	12,760	409,225	10,353	12,650
1964	486,998	12,418	12,750	431,116	10,899	12,640
1965	512,088	13,017	12,710	459,164	11,580	12,610
1966	533,881	13,507	12,650	486,266	12,205	12,550
1967	552,626	13,904	12,580	480,416	11,981	12,470
1968	545,245	13,664	12,530	498,830	12,401	12,430
1969	560,505	13,957	12,450	507,275	12,509	12,330
1970	602,932	14,820	12,290	515,619	12,488	12,110
1971	552,192	13,385	12,120	494,862	11,857	11,980
1972	595,386	14,319	12,025	516,776	12,273	11,875
1973	591,738	14,208	12,005	556,022	13,150	11,825
1974	603,406	14,320	11,865	552,709	12,750	11,535
1975	648,438	15,044	11,600	556,301	12,684	11,400

[1] Prior to 1955 the average heat content of the annual output of bituminous coal and lignite was measured at 13,100 Btu's per pound. This value was based on an estimate made in 1949 (U.S. Bureau of Mines Information Circular 7538). In recent years this heat value has not been representative of the average unit heat value of the total annual coal supply because of the large annual increases in utilization of coal of lower heat values by the electric utility industry. The annual production values shown in this table are weighted averages of known and estimated Btu values of coal shipments to each major consuming sector. They include, for example, the Btu value of coal consumed at electric utility generating plants as reported to the Federal Power Commission and compiled by the National Coal Association. Currently, electric utility plants account for 70% of total domestic coal consumption. The averages for U.S. consumption exclude shipments overseas and to Canada the preponderance of which is of high-Btu-value metallurgical coal thus accounting for the difference in values between total production and domestic consumption.

Table 6.—Estimated production of bituminous coal and lignite in the United States by week, 1974 and 1975

(Thousand short tons)

1974				1975			
Week ended—	Production	Maximum number of working days	Average production per working day	Week ended—	Production	Maximum number of working days	Average production per working day
Jan. 5	[1]8,233	[1]4	[2]2,058	Jan. 4	[1]6,751	[1]3.2	[2]2,110
Jan. 12	11,185	6	1,864	Jan. 11	13,060	6	2,177
Jan. 19	12,079	6	2,013	Jan. 18	11,344	6	1,891
Jan. 26	12,409	6	2,068	Jan. 25	11,959	6	1,993
Feb. 2	12,900	6	2,150	Feb. 1	12,722	6	2,120
Feb. 9	12,086	6	2,014	Feb. 8	12,644	6	2,107
Feb. 16	12,676	6	2,113	Feb. 15	12,751	6	2,125
Feb. 23	13,274	6	2,212	Feb. 22	12,857	6	2,143
Mar. 2	11,827	6	1,971	Mar. 1	13,566	6	2,261
Mar. 9	11,365	6	1,894	Mar. 8	13,133	6	2,189
Mar. 16	11,320	6	1,887	Mar. 15	11,917	6	1,986
Mar. 23	12,666	6	2,111	Mar. 22	12,535	6	2,089
Mar. 30	13,023	6	2,171	Mar. 29	12,155	6	2,026
Apr. 6	11,303	5	2,261	Apr. 5	10,986	5	2,197
Apr. 13	12,222	6	2,037	Apr. 12	12,095	6	2,016
Apr. 20	13,020	6	2,170	Apr. 19	12,950	6	2,158
Apr. 27	12,885	6	2,148	Apr. 26	12,764	6	2,127
May 4	12,846	6	2,141	May 3	12,571	6	2,095
May 11	13,064	6	2,177	May 10	12,900	6	2,150
May 18	13,019	6	2,170	May 17	12,989	6	2,165
May 25	12,868	6	2,145	May 24	13,112	6	2,185
June 1	11,479	5	2,296	May 31	11,514	5	2,303
June 8	12,842	6	2,140	June 7	13,958	6	2,326
June 15	13,166	6	2,194	June 14	13,898	6	2,316
June 22	13,150	6	2,192	June 21	13,721	6	2,287
June 29	8,265	3.7	2,234	June 28	13,283	6	2,214
July 6	6,202	2.9	2,139	July 5	6,965	3.0	2,322
July 13	11,829	6	1,972	July 12	7,894	3.5	2,255
July 20	12,161	6	2,027	July 19	10,814	4.7	2,301
July 27	12,185	6	2,031	July 26	11,853	5.2	2,279
Aug. 3	12,340	6	2,057	Aug. 2	12,992	6	2,165
Aug. 10	12,221	6	2,037	Aug. 9	13,689	6	2,282
Aug. 17	13,972	6	2,329	Aug. 16	12,824	6	2,137
Aug. 24	7,569	3.6	2,103	Aug. 23	11,969	6	1,995
Aug. 31	12,721	6	2,120	Aug. 30	10,046	6	1,674
Sept. 7	11,020	5	2,204	Sept. 6	9,446	5	1,889
Sept. 14	12,493	6	2,082	Sept. 13	13,526	6	2,254
Sept. 21	13,144	6	2,191	Sept. 20	14,242	6	2,374
Sept. 28	13,583	6	2,264	Sept. 27	13,666	6	2,278
Oct. 5	12,893	6	2,149	Oct. 4	13,551	6	2,259
Oct. 12	13,382	6	2,230	Oct. 11	13,577	6	2,263
Oct. 19	13,014	6	2,169	Oct. 18	13,205	6	2,201
Oct. 26	13,617	6	2,270	Oct. 25	13,352	6	2,225
Nov. 2	13,236	6	2,206	Nov. 1	12,603	6	2,101
Nov. 9	14,264	6	2,377	Nov. 8	14,191	6	2,365
Nov. 16	7,306	3.2	2,283	Nov. 15	13,520	6	2,253
Nov. 23	4,758	2.1	2,266	Nov. 22	13,836	6	2,306
Nov. 30	4,173	1.8	2,318	Nov. 29	11,723	5	2,345
Dec. 7	5,478	2.4	2,283	Dec. 6	13,739	6	2,290
Dec. 14	10,370	4.6	2,254	Dec. 13	14,273	6	2,379
Dec. 21	10,811	4.8	2,252	Dec. 20	13,462	6	2,244
Dec. 28	9,231	4.1	2,251	Dec. 27	8,274	3.6	2,298
Jan. 4	[1]4,261	[1]2	[2]2,131	Jan. 3	[1]5,071	[1]3	[2]1,690
Total or average	603,406	282.2	2,138		648,438	298.2	2,175

[1] Figures represent production and number of working days in that part of week included in calendar year shown.
[2] Average daily output for the working days in the calendar year shown.

Table 7.—Production of bituminous coal and lignite in the United States, by State and by month, 1975 [1]

(Thousand short tons)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Alabama	2,045	1,726	1,915	1,827	2,060	2,058	1,865	1,729	1,740	2,028	1,820	1,831	22,644
Alaska	60	65	65	60	65	64	64	64	65	66	63	65	766
Arizona	257	281	270	651	650	692	603	742	705	788	700	647	6,986
Arkansas	41	40	40	40	42	42	40	41	40	41	41	40	488
Colorado	414	394	589	666	705	812	694	874	856	773	690	752	8,219
Georgia	7	6	7	6	6	6	6	6	6	6	6	6	74
Illinois	5,685	5,268	5,156	5,196	5,362	5,029	3,988	4,053	4,982	5,278	4,677	4,863	59,537
Indiana	2,105	2,159	2,020	2,002	2,170	2,204	1,944	1,862	2,163	2,173	2,147	2,175	25,124
Iowa	67	50	56	44	52	44	56	48	39	53	61	52	622
Kansas	40	39	39	40	41	39	41	41	41	41	39	38	479
Kentucky:													
Eastern	7,787	6,986	7,212	7,589	7,855	7,730	6,652	6,979	7,973	7,650	6,200	6,644	87,257
Western	4,833	4,512	4,658	4,983	4,999	4,907	4,583	4,325	4,936	4,885	4,455	4,280	[2] 56,357
Total	12,620	11,498	11,870	12,572	12,854	12,637	11,235	11,304	12,909	12,535	10,655	10,924	[2] 143,613
Maryland	257	171	170	170	223	217	227	282	292	215	180	202	2,606
Missouri	474	399	382	411	455	482	385	525	524	566	506	529	5,638
Montana	1,127	1,703	1,893	1,524	1,851	1,878	1,737	2,077	1,913	2,330	2,124	1,897	22,054
New Mexico	772	741	760	579	567	565	741	930	954	802	672	702	8,785
North Dakota	445	453	445	605	672	645	733	865	739	1,135	826	952	8,515
Ohio	4,096	3,869	3,210	3,442	3,762	3,945	3,081	3,969	4,042	4,407	4,522	4,425	46,770
Oklahoma	205	189	240	257	265	278	247	232	225	262	246	226	2,872
Pennsylvania	7,597	6,667	7,140	7,285	7,295	6,920	5,340	6,836	7,006	7,790	7,236	7,025	84,137
Tennessee	665	655	603	765	751	777	770	882	812	568	478	480	8,206
Texas	752	894	946	785	790	799	672	1,092	1,114	1,250	865	1,043	11,002
Utah	569	555	528	570	560	553	567	612	567	657	644	579	6,961
Virginia	2,978	2,816	2,776	2,727	3,232	3,223	2,388	2,652	3,312	3,410	3,028	2,968	35,510
Washington	328	310	298	235	280	290	315	323	327	360	335	342	3,743
West Virginia	9,936	9,408	9,435	9,414	9,296	10,045	6,277	7,492	8,665	10,428	9,261	9,626	109,283
Wyoming	1,625	1,452	1,750	1,903	1,915	1,942	1,944	2,227	2,028	2,434	2,154	2,430	23,804
Total	55,167	51,808	52,603	53,776	55,921	56,186	45,960	51,760	56,066	60,396	53,976	54,819	648,438

[1] Figures are based principally upon railroad carloadings and river shipments supplemented by direct reports from certain local sources. Estimates for coal shipped by truck and used at the mines are included, and the totals represent output for all mines producing 1,000 tons or more per year.

[2] Data do not add to total shown because of independent rounding.

Table 8.—Production of bituminous coal and lignite in the United States, in 1975, by State and type of mining

(Thousand short tons)

State	Underground	Strip	Auger	Strip-auger	Total [1]
Alabama	7,614	15,018	11	--	22,644
Alaska	--	766	--	--	766
Arizona	--	6,986	--	--	6,986
Arkansas	--	488	--	--	488
Colorado	3,446	4,773	--	--	8,219
Georgia	--	74	--	--	74
Illinois	31,875	27,661	--	--	59,537
Indiana	188	24,935	--	--	25,124
Iowa	363	259	--	--	622
Kansas	--	479	--	--	479
Kentucky:					
Eastern	40,628	20,656	1,822	24,150	87,257
Western	25,004	31,022	--	331	56,357
Total	65,632	51,678	1,822	24,481	143,613
Maryland	104	2,466	36	--	2,606
Missouri	--	5,562	76	--	5,638
Montana:					
Bituminous	--	21,752	--	--	21,752
Lignite	--	302	--	--	302
Total	--	22,054	--	--	22,054
New Mexico	764	8,022	--	--	8,785
North Dakota (lignite)	--	8,515	--	--	8,515
Ohio	15,455	24,908	495	5,912	46,770
Oklahoma	--	2,872	--	--	2,872
Pennsylvania	44,631	39,105	354	48	84,137
Tennessee	3,806	4,231	152	17	8,206
Texas (lignite)	--	11,002	--	--	11,002
Utah	6,961	--	--	--	6,961
Virginia	23,181	9,145	536	2,648	35,510
Washington	13	3,730	--	--	3,743
West Virginia	88,357	16,846	46	4,034	109,283
Wyoming	436	23,369	--	--	23,804
Total [1]	292,826	314,945	3,526	37,141	648,438

[1] Data may not add to totals shown because of independent rounding.

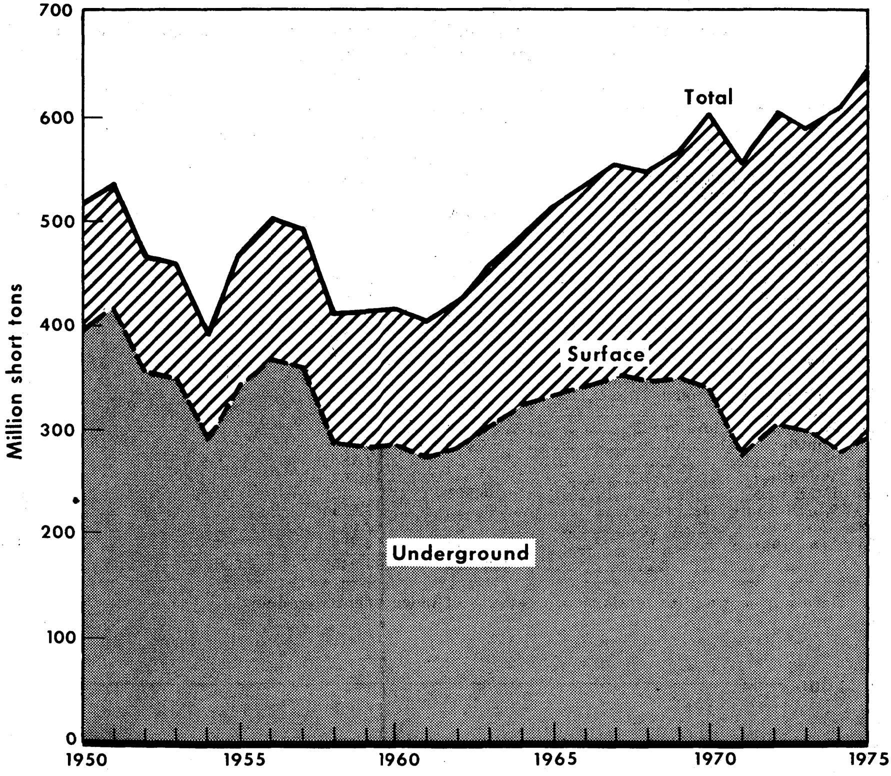

Figure 1.—Production of bituminous coal and lignite, by type of mining in the United States.

Table 9.—Production of bituminous coal and lignite in the United States, in 1975, by district and type of mining

(Thousand short tons)

	District	Underground	Strip	Auger	Strip-auger	Total [1]
1	Eastern Pennsylvania	22,290	32,382	304	48	55,024
2	Western Pennsylvania	23,913	10,235	85	--	34,233
3	Northern West Virginia	24,960	8,277	10	1,887	35,133
4	Ohio	15,455	24,908	495	5,912	46,770
5	Michigan	--	--	--	--	--
6	Panhandle	7,331	87	--	--	7,418
7	Southern Number 1	23,597	2,698	121	641	27,057
8	Southern Number 2	97,760	38,281	2,433	28,321	166,795
9	West Kentucky	25,004	31,022	--	331	56,357
10	Illinois	31,875	27,661	--	--	59,537
11	Indiana	188	24,935	--	--	25,124
12	Iowa	363	259	--	--	622
13	Southeastern	8,470	15,572	13	--	24,056
14	Arkansas-Oklahoma	--	1,053	--	--	1,053
15	Southwestern	--	19,361	67	--	19,428
16	Northern Colorado	163	321	--	--	483
17	Southern Colorado	4,047	4,704	--	--	8,751
18	New Mexico	--	14,755	--	--	14,755
19	Wyoming	436	23,369	--	--	23,804
20	Utah	6,961	--	--	--	6,961
21	North-South Dakota	--	8,515	--	--	8,515
22	Montana	--	22,054	--	--	22,054
23	Washington	13	4,496	--	--	4,509
	Total [1]	292,826	314,945	3,526	37,141	648,438

[1] Data may not add to totals shown because of independent rounding.

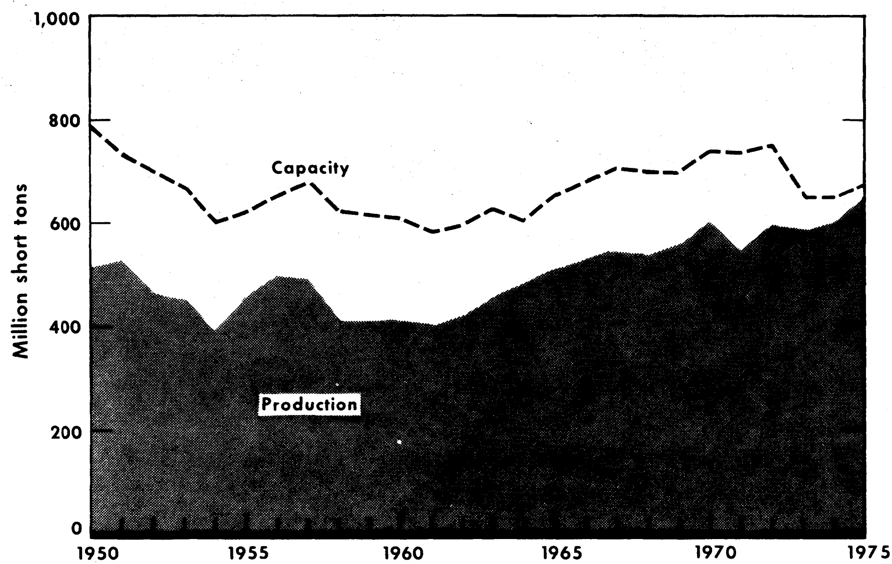

Figure 2.—Trends of bituminous coal and lignite production, realization, and mine capacity in the United States.

Table 10.—Number of mines, production, value, men working daily, days worked, and output per man per hour and per day at bituminous coal and lignite mines in the United States, in 1975, by State

State	Number of active mines	Production (thousand short tons): Shipped by rail or water [1]	Shipped by truck	Mine-mouth generating plants	All other [2]	Total [3]	Average value per ton [4]	Average number of men working daily	Average number of days worked	Average tons per man per hour	Average tons per man per day
Alabama	236	14,533	5,568	2,023	520	22,644	$26.53	8,400	241	1.43	11.19
Alaska	1	625	141	--	--	766	W	80	312	5.77	30.65
Arizona	2	2,818	--	--	4,168	6,986	W	450	225	9.61	69.66
Arkansas	8	411	62	--	16	488	32.76	180	329	1.12	8.25
Colorado	33	7,121	328	706	64	8,219	16.53	1,840	236	2.39	18.89
Georgia	3	61	13	--	--	74	W	40	216	1.23	9.79
Illinois	58	48,323	4,062	7,062	89	59,537	14.64	12,850	263	2.28	17.61
Indiana	62	20,069	5,015	1	39	25,124	11.15	3,040	280	3.90	29.50
Iowa	10	90	507	25	--	622	11.08	120	268	2.35	20.15
Kansas	4	381	95	--	4	479	19.78	130	268	1.72	13.76
Kentucky:											
Eastern	2,219	76,929	9,183	791	354	87,257	20.79	25,450	223	1.80	15.40
Western	182	46,123	2,268	7,928	39	56,357	12.16	10,620	262	2.58	20.22
Total [3]	2,401	123,051	11,451	8,718	393	143,613	17.40	36,070	234	2.04	16.99
Maryland	69	1,579	1,027	--	--	2,606	19.38	580	216	2.57	20.69
Missouri	13	1,775	79	3,783	2	5,638	8.52	890	300	2.90	21.14
Montana:											
Bituminous	6	21,466	17	268	--	21,752	5.06	620	271	15.99	129.66
Lignite	2	300	2	--	--	302	W	20	234	6.70	53.59
Total [3]	8	21,766	20	268	--	22,054	5.06	640	270	15.69	127.25
New Mexico	5	1,482	--	7,301	2	8,785	W	930	257	4.66	36.86
North Dakota (lignite)	10	4,347	311	3,837	20	8,515	3.17	380	255	11.28	86.86
Ohio	348	28,446	12,592	5,683	49	46,770	16.40	13,430	230	1.83	15.13
Oklahoma	31	2,594	277	--	1	2,872	16.69	870	224	1.94	14.79
Pennsylvania	835	52,375	23,702	7,456	605	84,137	25.09	29,960	245	1.39	11.46
Tennessee	166	5,440	2,621	40	105	8,206	17.10	3,140	201	1.54	12.94
Texas (lignite)	4	--	268	8,934	1,800	11,002	W	440	324	9.56	76.49
Utah	20	5,032	748	1,065	116	6,961	19.84	2,550	197	1.76	13.85
Virginia	745	30,381	5,125	--	3	35,510	30.46	16,510	201	1.33	10.69
Washington	4	--	25	3,718	--	3,743	W	520	268	3.39	27.11
West Virginia	1,072	97,958	5,225	5,915	185	109,283	29.35	54,210	220	1.15	9.15
Wyoming	20	16,584	105	7,006	110	23,804	6.74	1,630	237	7.73	61.78
Total [3]	6,168	487,243	79,365	73,543	8,288	648,438	19.23	189,880	232	1.83	14.74

W Withheld to avoid disclosing individual company confidential data.
[1] Includes coal loaded at mines directly into railroad cars or river barges, hauled by trucks to railroad siding, and hauled by trucks to waterways.
[2] Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for other purposes at mine, and shipped by slurry pipeline in Arizona.
[3] Data may not add to totals shown because of independent rounding.
[4] Value received or charged for coal, f.o.b. mine. Includes a value, estimated by producer, for coal not sold.

Table 11.—Number of mines, production, value, men working daily, days worked, and output per man per hour and per day at bituminous coal and lignite mines in the United States, in 1975, by district

	District	Number of active mines	Production (thousand short tons)					Average value per ton [4]	Average number of men working daily	Average number of days worked	Average tons per man per hour	Average tons per man per day
			Shipped by rail or water [1]	Shipped by truck	Mine-mouth generating plants	All other [2]	Total [3]					
1	Eastern Pennsylvania	659	30,325	16,676	7,554	468	55,024	$21.84	18,490	237	1.50	12.53
2	Western Pennsylvania	277	25,562	8,381	154	137	34,233	29.11	12,920	256	1.28	10.36
3	Northern West Virginia	320	30,424	2,420	2,277	12	35,133	22.65	11,680	232	1.61	12.99
4	Ohio	348	28,446	12,592	5,683	49	46,770	16.40	13,430	230	1.83	15.13
5	Michigan	--	--	--	--	--	--	--	--	--	--	--
6	Panhandle	12	3,923	299	3,164	33	7,418	15.29	3,470	222	1.24	9.63
7	Southern Number 1	368	25,668	1,269	--	120	27,057	41.97	17,700	224	.86	6.82
8	Southern Number 2	3,438	147,801	17,460	1,052	482	166,795	24.80	64,960	212	1.47	12.12
9	West Kentucky	182	46,123	2,268	7,928	39	56,357	12.16	10,620	262	2.58	20.22
10	Illinois	58	48,323	4,062	7,062	89	59,537	14.64	12,850	263	2.28	17.61
11	Indiana	62	20,069	5,015	1	39	25,124	11.15	3,040	280	3.90	29.50
12	Iowa	10	90	507	25	--	622	11.08	120	268	2.35	20.15
13	Southeastern	271	15,554	5,959	2,023	520	24,056	26.12	9,060	239	1.41	11.09
14	Arkansas-Oklahoma	22	920	115	--	17	1,053	34.47	480	215	1.33	10.22
15	Southwestern	38	4,241	665	12,717	1,806	19,428	6.07	2,040	293	4.31	32.61
16	Northern Colorado	4	471	13	--	--	483	11.93	120	204	2.43	20.48
17	Southern Colorado	31	7,666	316	706	64	8,751	18.27	2,120	238	2.20	17.30
18	New Mexico	5	3,284	--	7,301	4,170	14,755	W	980	249	7.86	60.44
19	Wyoming	20	16,584	105	7,006	110	23,804	6.74	1,630	237	7.73	61.78
20	Utah	20	5,032	748	1,065	116	6,961	19.84	2,550	197	1.76	13.85
21	North-South Dakota	10	4,347	311	3,837	20	8,515	3.17	380	255	11.28	86.86
22	Montana	8	21,766	20	268	--	22,054	5.06	640	270	15.69	127.25
23	Washington	5	625	166	3,718	--	4,509	W	600	278	3.64	27.65
	Total [3]	6,168	487,243	79,365	73,543	8,288	648,438	19.23	189,880	232	1.83	14.74

W Withheld to avoid disclosing individual company confidential data.
[1] Includes coal loaded at mines directly into railroad cars or river barges, hauled by trucks to railroad siding, and hauled by trucks to waterways.
[2] Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for other purposes at mine, and shipped by slurry pipeline in Arizona.
[3] Data may not add to totals shown because of independent rounding.
[4] Value received or charged for coal, f.o.b. mine. Includes a value, estimated by producer, for coal not sold.

Table 12.—Average value per ton, f.o.b. mines, of bituminous coal and lignite produced in the United States, by State

State	1974 Underground	1974 Strip	1974 Auger	1974 Strip-auger	1974 Total	1975 Underground	1975 Strip	1975 Auger	1975 Strip-auger	1975 Total
Alabama	$30.30	$17.84	--	--	$21.79	$33.77	$22.87	W	--	$26.53
Alaska	--	W	--	--	W	--	W	--	--	W
Arizona	--	W	--	--	W	--	W	--	--	W
Arkansas	--	21.28	--	--	21.28	--	32.76	--	--	32.76
Colorado	13.89	5.33	--	--	9.38	27.16	8.86	--	--	16.53
Georgia	--	--	--	--	--	--	W	--	--	W
Illinois	11.12	8.70	--	--	10.00	16.30	12.72	--	--	14.64
Indiana	W	8.36	--	--	8.36	W	11.14	--	--	11.15
Iowa	W	9.15	--	--	7.79	W	11.72	--	--	11.08
Kansas	--	7.61	--	--	7.61	--	19.78	--	--	19.78
Kentucky:										
Eastern	24.72	15.01	$16.91	$22.52	22.01	27.03	15.24	$15.15	$15.46	20.79
Western	10.25	7.86	--	--	8.92	13.73	10.90	--	12.00	12.16
Total	19.48	10.46	16.91	22.52	17.06	21.96	12.64	15.15	15.41	17.40
Maryland	W	20.58	--	22.64	20.81	17.97	19.44	19.56	--	19.38
Missouri	--	6.36	--	--	6.36	--	8.54	W	--	8.52
Montana:										
Bituminous	--	3.91	--	--	3.91	--	5.06	--	--	5.06
Lignite	--	W	--	--	W	--	W	--	--	W
Total	--	3.90	--	--	3.90	--	5.06	--	--	5.06
New Mexico	W	W	--	--	W	W	W	--	--	W
North Dakota (lignite)	--	2.19	--	--	2.19	--	3.17	--	--	3.17
Ohio	13.70	12.42	9.95	10.18	12.32	18.76	15.57	19.52	13.43	16.40
Oklahoma	--	9.84	--	e 19.40	10.51	--	16.69	--	--	16.69
Pennsylvania	22.63	18.01	15.30	14.21	20.35	30.41	19.09	17.34	19.21	25.09
Tennessee	13.70	22.05	11.69	17.58	18.02	15.76	18.27	17.71	17.63	17.10
Texas (lignite)	--	W	--	--	W	--	W	--	--	W
Utah	12.24	--	--	--	12.24	19.84	--	--	--	19.84
Virginia	25.87	25.35	17.85	18.46	24.94	34.44	23.72	21.69	20.70	30.46
Washington	28.70	W	--	--	W	20.03	W	--	--	W
West Virginia	21.76	22.46	21.74	16.34	21.65	30.60	25.52	34.29	17.75	29.35
Wyoming	10.19	4.88	--	--	5.02	W	6.61	--	--	6.74
Total	19.86	11.11	16.99	18.49	15.75	26.28	13.12	17.22	15.73	19.23

e Estimate. W Withheld to avoid disclosing individual company confidential data.

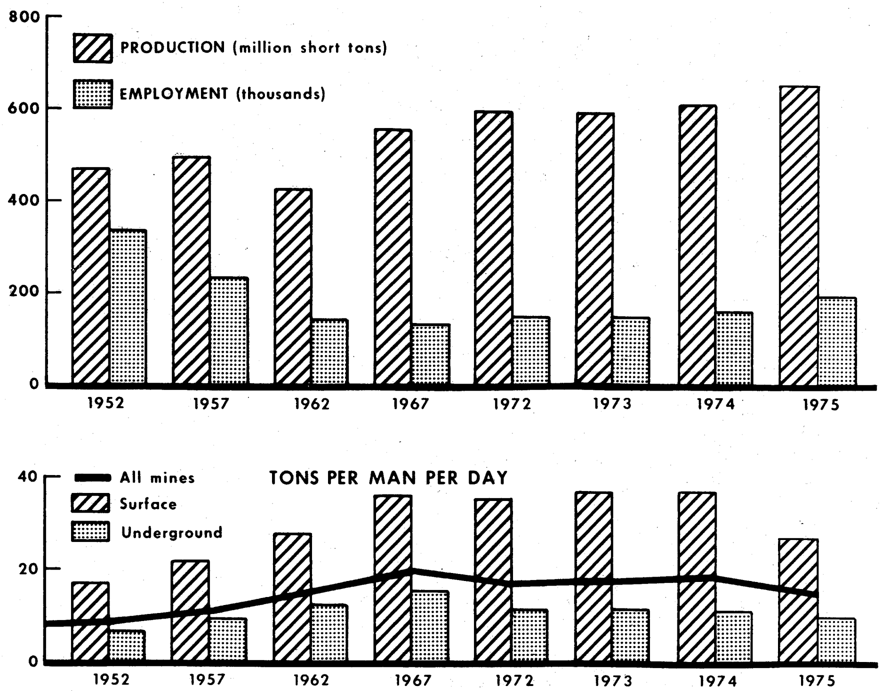

Figure 3.—Trends in employment and output per man at bituminous coal and lignite mines in the United States.

Table 13.—Average value per ton, f.o.b. mines, of bituminous coal and lignite produced, by district

District	1974					1975				
	Underground	Strip	Auger	Strip-auger	Total	Underground	Strip	Auger	Strip-auger	Total
1 Eastern Pennsylvania	$19.72	$18.49	$14.90	$15.28	$18.84	$25.52	$19.35	$18.15	$19.21	$21.84
2 Western Pennsylvania	24.61	17.18	15.92	18.40	22.51	33.95	17.94	15.38	--	29.11
3 Northern West Virginia	15.75	18.41	13.43	13.28	16.22	24.73	18.88	19.10	11.71	22.65
4 Ohio	13.70	12.42	9.95	10.18	12.32	18.76	15.57	19.52	13.43	16.40
5 Michigan	--	--	--	--	--	--	--	--	--	--
6 Panhandle	12.20	14.84	22.24	--	12.23	15.27	17.36	--	--	15.29
7 Southern Number 1	28.88	28.44	17.50	24.91	28.72	42.89	37.60	26.34	29.42	41.97
8 Southern Number 2	24.44	19.88	--	21.87	22.93	29.50	19.66	16.55	16.21	24.80
9 West Kentucky	10.25	7.86	--	--	8.92	13.73	10.90	--	12.00	12.16
10 Illinois	11.12	8.70	--	--	10.00	16.30	12.72	--	--	14.64
11 Indiana	W	8.36	--	--	8.36	W	11.14	--	--	11.15
12 Iowa	W	9.15	--	--	7.79	W	11.72	--	--	11.08
13 Southeastern	28.89	17.98	--	W	21.58	31.98	22.94	16.61	--	26.12
14 Arkansas-Oklahoma	--	20.63	--	[e] 19.40	20.39	--	34.47	--	--	34.47
15 Southwestern	--	4.63	--	--	4.63	--	6.06	7.62	--	6.07
16 Northern Colorado	W	W	--	--	6.49	W	W	--	--	11.93
17 Southern Colorado	14.68	6.19	--	--	10.15	28.42	9.72	--	--	18.37
18 New Mexico	--	3.15	--	--	3.15	--	W	--	--	W
19 Wyoming	10.19	4.88	--	--	5.02	W	6.61	--	--	6.74
20 Utah	12.24	--	--	--	12.24	19.84	--	--	--	19.84
21 North-South Dakota	--	2.19	--	--	2.19	--	3.17	--	--	3.17
22 Montana	--	3.90	--	--	3.90	--	5.06	--	--	5.06
23 Washington	28.70	6.34	--	--	6.42	20.03	W	--	--	W
Total	19.86	11.11	16.99	18.49	15.75	26.28	13.12	17.22	15.73	19.23

[e] Estimate. W Withheld to avoid disclosing individual company confidential data.

Table 14.—Production and average value per ton, f.o.b. mines, of bituminous coal and lignite sold in open market and not sold in open market, in 1975, by State

State	Production (thousand short tons)			Average value per ton, f.o.b. mines		
	Sold in open market	Not sold in open market	Total [1]	Sold in open market	Not sold in open market	Total
Alabama	18,643	4,001	22,644	$25.40	$31.81	$26.53
Alaska	766	--	766	W	--	W
Arizona	6,986	--	6,986	W	--	W
Arkansas	W	W	488	24.16	W	32.76
Colorado	W	W	8,219	11.59	W	16.53
Georgia	74	--	74	W	--	W
Illinois	W	W	59,537	14.12	W	14.64
Indiana	25,124	--	25,124	11.15	--	11.15
Iowa	622	--	622	11.08	--	11.08
Kansas	479	--	479	19.78	--	19.78
Kentucky:						
Eastern	W	W	87,257	18.38	41.10	20.79
Western	W	W	56,357	12.15	W	12.16
Total	133,847	9,766	143,613	15.79	39.57	17.40
Maryland	2,606	--	2,606	19.38	--	19.38
Missouri	5,638	--	5,638	8.52	--	8.52
Montana:						
Bituminous	21,752	--	21,752	5.06	--	5.06
Lignite	W	W	302	W	W	W
Total	W	W	22,054	5.06	W	5.06
New Mexico	W	W	8,785	W	W	W
North Dakota (lignite)	W	W	8,515	2.90	W	3.17
Ohio	W	W	46,770	16.34	W	16.40
Oklahoma	W	W	2,872	16.67	W	16.69
Pennsylvania	59,337	24,800	84,137	20.66	35.68	25.09
Tennessee	8,206	--	8,206	17.10	--	17.10
Texas (lignite)	W	W	11,002	W	W	W
Utah	4,280	2,680	6,961	14.21	28.84	19.84
Virginia	W	W	35,510	30.27	W	30.46
Washington	25	3,718	3,743	17.82	W	W
West Virginia	95,366	13,917	109,283	28.04	38.31	29.35
Wyoming	W	W	23,804	7.18	W	6.74
Undistributed	176,909	28,895	--	4.39	11.00	5.18
Total [1]	560,660	87,778	648,438	18.02	26.99	19.23

W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.

Table 15.—Number of mines, men working daily, days worked, and output per man per day and per hour at bituminous coal and lignite mines in the United States, in 1975, by State

State	Number of mines		Average number of men working daily			Average number of days worked		Average tons per man per day			Average tons per man per hour		
	Underground	Surface	Underground	Surface	Total [1]	Underground	Surface	Underground	Surface	Total	Underground	Surface	Total
Alabama	20	216	4,420	3,980	8,400	235	247	7.23	15.29	11.19	0.92	1.98	1.43
Alaska	--	1	--	80	80	--	312	--	30.65	30.65	--	5.77	5.77
Arizona	--	2	--	450	450	--	225	--	69.66	69.66	--	9.61	9.61
Arkansas	--	8	--	180	180	--	329	--	8.25	8.25	--	1.12	1.12
Colorado	18	15	1,360	490	1,840	243	215	10.43	45.62	18.89	1.31	5.93	2.39
Georgia [e]	--	3	--	40	40	--	216	--	9.79	9.79	--	1.23	1.23
Illinois	21	37	9,010	3,840	12,850	248	298	14.25	24.19	17.61	1.83	3.17	2.28
Indiana	2	60	80	2,960	3,040	138	284	16.10	29.69	29.50	2.01	3.93	3.90
Iowa	2	8	60	60	120	294	244	22.06	17.98	20.15	2.47	2.20	2.35
Kansas	--	4	--	130	130	--	268	--	13.76	13.76	--	1.72	1.72
Kentucky:													
Eastern	869	1,350	15,500	9,950	25,450	231	210	11.36	22.30	15.40	1.40	2.39	1.80
Western	27	155	6,700	3,920	10,620	258	270	14.48	29.56	20.22	1.81	3.90	2.58
Total	896	1,505	22,200	13,870	36,070	239	227	12.38	24.74	16.99	1.53	2.83	2.04
Maryland	2	67	50	530	580	217	216	9.59	21.74	20.69	1.22	2.69	2.57
Missouri	--	13	--	890	890	--	300	--	21.14	21.14	--	2.90	2.90
Montana:													
Bituminous	--	6	--	620	620	--	271	--	129.66	129.66	--	15.99	15.99
Lignite	--	2	--	20	20	--	234	--	53.59	53.59	--	6.70	6.70
Total	--	8	--	640	640	--	270	--	127.25	127.25	--	15.69	15.69
New Mexico	1	4	340	590	930	240	266	9.34	51.23	36.86	1.19	6.45	4.66
North Dakota (lignite)	--	10	--	380	380	--	255	--	86.86	86.86	--	11.28	11.28
Ohio	33	315	8,730	4,700	13,430	216	256	8.19	25.97	15.13	1.01	3.04	1.83
Oklahoma	--	31	--	870	870	--	224	--	14.79	14.79	--	1.94	1.94
Pennsylvania	132	703	21,980	7,980	29,960	247	240	8.23	20.59	11.46	1.00	2.46	1.39
Tennessee	62	104	1,890	1,250	3,140	204	198	9.87	17.71	12.94	1.23	1.97	1.54
Texas (lignite)	--	4	--	440	440	--	324	--	76.49	76.49	--	9.56	9.56
Utah	20	--	2,550	--	2,550	197	--	13.85	--	13.85	1.76	--	1.76
Virginia	374	371	13,360	3,150	16,510	202	199	8.61	19.66	10.69	1.08	2.36	1.33
Washington	1	3	10	500	520	240	269	5.27	27.49	27.11	.65	3.43	3.39
West Virginia	703	369	48,400	5,810	54,210	221	212	8.24	17.01	9.15	1.04	2.16	1.15
Wyoming	5	15	270	1,360	1,630	149	254	10.79	67.74	61.78	1.32	8.50	7.73
Total [1]	2,292	3,876	134,710	55,170	189,880	228	241	9.54	26.69	14.74	1.19	3.26	1.83

[e] Estimate.
[1] Data may not add to totals shown because of independent rounding.

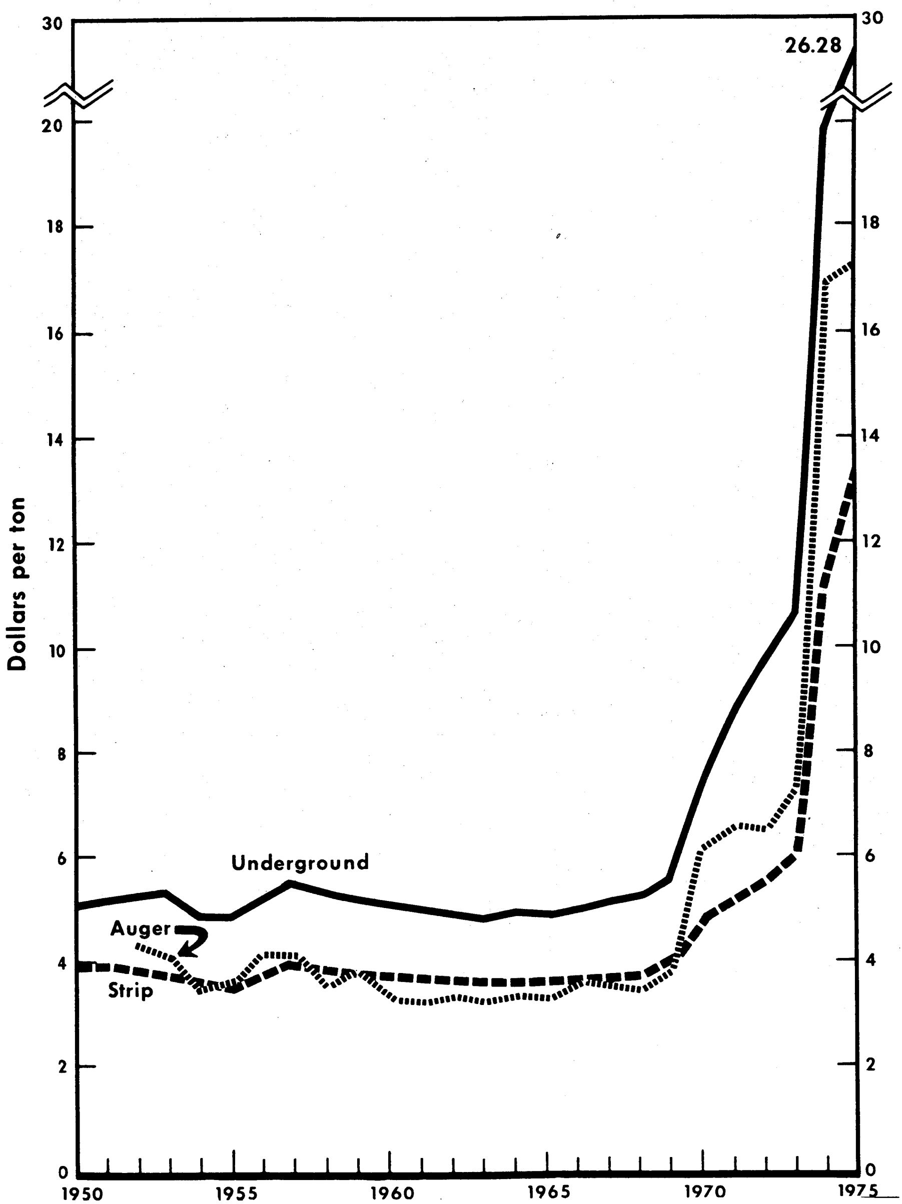

Figure 4.—Average value per ton f.o.b. mines, of bituminous coal and lignite produced in the United States, by type of mining.

Table 16.—Number of mines, men working daily, days worked, and output per man per day and per hour at bituminous coal and lignite mines in the United States, in 1975, by district

District	Number of mines		Average number of men working daily			Average number of days worked		Average tons per man per day			Average tons per man per hour		
	Underground	Surface	Underground	Surface	Total [1]	Underground	Surface	Underground	Surface	Total	Underground	Surface	Total
1 Eastern Pennsylvania	94	565	11,730	6,770	18,500	233	244	8.14	19.82	12.53	0.97	2.37	1.50
2 Western Pennsylvania	45	232	11,020	1,900	12,920	261	222	8.30	24.34	10.36	1.03	2.94	1.28
3 Northern West Virginia	139	181	9,440	2,230	11,670	233	226	11.34	20.20	12.99	1.40	2.59	1.61
4 Ohio	33	315	8,730	4,700	13,430	216	256	8.19	25.97	15.13	1.01	3.04	1.83
5 Michigan	--	--	--	--	--	--	--	--	--	--	--	--	--
6 Panhandle	8	4	3,440	30	3,470	228	154	9.58	16.72	9.63	1.24	2.09	1.24
7 Southern Number 1	272	96	16,360	1,340	17,700	226	195	6.37	13.25	6.82	.80	1.69	.86
8 Southern Number 2	1,568	1,870	48,710	16,250	64,960	214	206	9.40	20.57	12.12	1.17	2.30	1.47
9 West Kentucky	27	155	6,700	3,920	10,620	258	270	14.48	29.56	20.22	1.81	3.90	2.58
10 Illinois	21	37	9,010	3,840	12,850	248	298	14.25	24.19	17.61	1.83	3.17	2.28
11 Indiana	2	60	80	2,960	3,040	138	284	16.10	29.69	29.50	2.01	3.93	3.90
12 Iowa	2	8	60	60	120	294	244	22.06	17.98	20.15	2.47	2.20	2.35
13 Southeastern	36	235	4,900	4,160	9,060	235	245	7.36	15.30	11.09	.92	1.97	1.41
14 Arkansas-Oklahoma	--	22	--	480	480	--	215	--	10.22	10.22	--	1.33	1.33
15 Southwestern	--	38	--	2,040	2,040	--	293	--	32.61	32.61	--	4.31	4.31
16 Northern Colorado	1	3	60	60	120	196	211	14.06	26.64	20.48	1.76	3.02	2.43
17 Southern Colorado	18	13	1,640	480	2,120	244	218	10.10	44.67	17.30	1.27	5.94	2.20
18 New Mexico	--	5	--	980	980	--	249	--	60.44	60.44	--	7.86	7.86
19 Wyoming	5	15	270	1,360	1,630	149	254	10.79	67.74	61.78	1.32	8.50	7.73
20 Utah	20	--	2,550	--	2,550	197	--	13.85	--	13.85	1.76	--	1.76
21 North-South Dakota	--	10	--	380	380	--	255	--	86.86	86.86	--	11.28	11.28
22 Montana	--	8	--	640	640	--	270	--	127.25	127.25	--	15.69	15.69
23 Washington	1	4	10	590	600	240	275	5.27	27.99	27.65	.65	3.69	3.64
Total [1]	2,292	3,876	134,710	55,170	189,880	228	241	9.54	26.69	14.74	1.19	3.26	1.83

[1] Data may not add to totals shown because of independent rounding.

Table 17.—Number and production of bituminous coal and lignite mines, in 1975, by State, size of output, and type of mining

(Thousand short tons)

State	500,000 tons and over		200,000 to 499,999 tons		100,000 to 199,999 tons		50,000 to 99,999 tons		10,000 to 49,999 tons		Less than 10,000 tons		Total [1]	
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity
Alabama:														
Underground	6	5,562	5	1,789	--	--	2	168	3	63	4	32	20	7,614
Strip	6	4,599	12	3,476	19	2,825	30	2,062	75	1,700	73	357	215	15,018
Auger	--	--	--	--	--	--	--	--	1	11	--	--	1	11
Total [1]	12	10,161	17	5,266	19	2,825	32	2,230	79	1,773	77	388	236	22,644
Alaska: Strip	1	766	--	--	--	--	--	--	--	--	--	--	1	766
Arizona: Strip	2	6,986	--	--	--	--	--	--	--	--	--	--	2	6,986
Arkansas: Strip	--	--	1	211	1	106	1	95	3	70	2	5	8	488
Colorado:														
Underground	2	1,357	4	1,379	3	407	3	229	3	66	3	8	18	3,446
Strip	5	3,958	2	476	2	214	1	65	3	55	2	5	15	4,773
Total	7	5,315	6	1,855	5	621	4	294	6	121	5	13	33	8,219
Georgia: Strip	--	--	--	--	--	--	1	56	1	13	1	5	3	74
Illinois:														
Underground	19	31,322	1	453	1	101	--	--	--	--	--	--	21	31,875
Strip	18	26,237	2	765	--	--	5	379	9	270	3	9	37	27,661
Total [1]	37	57,559	3	1,218	1	101	5	379	9	270	3	9	58	59,537
Indiana:														
Underground	--	--	--	--	--	--	2	188	--	--	--	--	2	188
Strip	13	22,176	1	814	5	751	10	668	18	474	13	53	60	24,935
Total [1]	13	22,176	1	814	5	751	12	857	18	474	13	53	62	25,124
Iowa:														
Underground	--	--	1	272	--	--	1	91	--	--	--	--	2	363
Strip	--	--	--	--	--	--	2	129	5	128	1	2	8	259
Total	--	--	1	272	--	--	3	220	5	128	1	2	10	622
Kansas: Strip	--	--	1	235	1	190	--	--	1	46	1	8	4	479
Kentucky:														
Eastern:														
Underground	12	9,205	33	9,892	51	7,207	88	5,900	304	6,871	381	1,553	869	40,628
Strip	4	7,186	13	3,281	27	3,489	42	2,842	140	3,302	121	557	347	20,656
Auger	--	--	--	--	2	210	9	601	42	797	49	213	102	1,822
Strip-auger	2	1,380	9	2,873	21	2,916	89	6,250	423	9,089	357	1,643	901	24,150
Total [1]	18	17,772	55	16,046	101	13,822	228	15,593	909	20,058	908	3,966	2,219	87,257
Western:														
Underground	21	24,220	1	426	1	168	2	112	2	78	--	--	27	25,004
Strip	17	24,961	8	2,581	9	1,247	11	715	53	1,257	48	261	146	31,022

Strip-auger	--	--	--	--	1	144	1	86	4	88	3	13	9	331
Total [1]	38	49,181	9	3,007	11	1,560	14	912	59	1,424	51	274	182	56,357
Total Kentucky:														
Underground	33	33,425	34	10,318	52	7,375	90	6,012	306	6,949	381	1,553	896	65,632
Strip	21	32,147	21	5,862	36	4,736	53	3,557	193	4,559	169	818	493	51,678
Auger	--	--	--	--	2	210	9	601	42	797	49	213	102	1,822
Strip-auger	2	1,380	9	2,873	22	3,060	90	6,336	427	9,177	360	1,656	910	24,481
Total [1]	56	66,952	64	19,053	112	15,382	242	16,505	968	21,482	959	4,240	2,401	143,613
Maryland:														
Underground	--	--	--	--	--	--	1	72	1	32	--	--	2	104
Strip	--	--	1	250	4	566	13	846	29	739	14	66	61	2,466
Auger	--	--	--	--	--	--	--	--	2	25	4	11	6	36
Total [1]	--	--	1	250	4	566	14	918	32	795	18	77	69	2,606
Missouri:														
Strip	5	4,454	3	1,080	--	--	--	--	1	13	3	15	12	5,562
Auger	--	--	--	--	--	--	1	76	--	--	--	--	1	76
Total	5	4,454	3	1,080	--	--	1	76	1	13	3	15	13	5,638
Montana: Strip	4	21,735	1	300	--	--	--	--	--	--	3	19	8	22,054
New Mexico:														
Underground	1	764	--	--	--	--	--	--	--	--	--	--	1	764
Strip	2	7,301	2	721	--	--	--	--	--	--	--	--	4	8,022
Total [1]	3	8,065	2	721	--	--	--	--	--	--	--	--	5	8,785
North Dakota: Strip	5	7,630	2	729	1	142	--	--	1	10	1	4	10	8,515
Ohio:														
Underground	14	13,168	4	1,515	3	488	3	193	2	48	7	43	33	15,455
Strip	7	6,132	23	7,262	28	4,045	61	4,577	95	2,572	53	319	267	24,908
Auger	--	--	--	--	--	--	2	120	12	328	11	46	25	495
Strip-auger	4	4.826	1	349	1	106	1	93	16	539	--	--	23	5,912
Total [1]	25	24,126	28	9,126	32	4,639	67	4,983	125	3,488	71	408	348	46,770
Oklahoma: Strip	2	1,426	--	--	7	959	2	149	13	304	7	35	31	2,872
Pennsylvania:														
Underground	34	30,192	32	10,599	17	2,437	13	921	17	390	19	90	132	44,631
Strip	7	6,473	27	8,304	64	8,944	102	7,250	273	7,214	188	919	661	39,105
Auger	--	--	--	--	--	--	--	--	15	251	24	103	39	354
Strip-auger	--	--	--	--	--	--	--	--	2	45	1	3	3	48
Total [1]	41	36,665	59	18,903	81	11,382	115	8,172	307	7,901	232	1,115	835	84,137
Tennessee:														
Underground	1	925	2	560	6	835	12	763	25	647	16	76	62	3,806
Strip	--	--	3	743	11	1,328	16	993	42	1,059	22	106	94	4,231
Auger	--	--	--	--	--	--	--	--	5	132	4	20	9	152
Strip-auger	--	--	--	--	--	--	--	--	1	17	--	--	1	17
Total [1]	1	925	5	1,303	17	2,163	28	1,756	73	1,856	42	202	166	8,206
Texas: Strip	3	10,735	1	267	--	--	--	--	--	--	--	--	4	11,002
Utah: Underground	5	3,830	6	2,349	3	460	3	251	2	62	1	9	20	6,961

See footnotes at end of table.

Table 17.—Number and production of bituminous coal and lignite mines, in 1975, by State, size of output, and type of mining—Continued

(Thousand short tons)

State	500,000 tons and over		200,000 to 499,999 tons		100,000 to 199,999 tons		50,000 to 99,999 tons		10,000 to 49,999 tons		Less than 10,000 tons		Total[1]	
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity
Virginia:														
Underground	5	3,308	26	7,680	28	3,762	40	2,808	225	5,378	50	244	374	23,181
Strip	--	--	4	979	15	2,134	29	1,905	136	3,585	121	542	305	9,145
Auger	--	--	--	--	--	--	--	--	26	515	4	20	30	536
Strip-auger	--	--	2	556	7	934	11	754	12	388	4	17	36	2,648
Total	5	3,308	32	9,215	50	6,830	80	5,467	225	5,378	50	244	374	23,181
Washington:														
Underground	--	--	--	--	--	--	--	--	1	13	--	--	1	13
Strip	1	3.718	--	--	--	--	--	--	--	--	2	12	3	3,730
Total	1	3,718	--	--	--	--	--	--	1	13	2	12	4	3,743
West Virginia:														
Underground	43	38,728	78	23,910	82	11,193	110	7,873	215	5,867	175	786	703	88,357
Strip	1	655	10	2,857	35	4,936	61	4,317	143	3,644	73	437	323	16,846
Auger	--	--	--	--	--	--	--	--	1	35	2	11	3	46
Strip-auger	1	691	3	1,032	5	720	17	1,220	13	347	4	25	43	4,034
Total[1]	45	40,074	91	27,798	122	16,849	188	13,409	372	9,893	254	1,259	1,072	109,283
Wyoming:														
Underground	--	--	--	--	2	285	2	150	--	--	1	1	5	436
Strip	11	22,679	2	669	--	--	--	--	1	18	1	3	15	23,369
Total[1]	11	22,679	2	669	2	285	2	150	1	18	2	4	20	23,804
United States:														
Underground	163	162,581	193	60,824	197	27,343	282	19,720	800	19,515	657	2,842	2,292	292,826
Strip	114	189,807	119	36,000	229	31,876	387	27,048	1,042	26,473	753	3,740	2,644	314,945
Auger	--	--	--	--	2	210	12	797	104	2,094	98	425	216	3,526
Strip-auger	7	6,897	15	4,809	35	4,820	119	8,403	471	10,514	369	1,699	1,016	37,141
Total[1]	284	359,284	327	101,633	463	64,250	800	55,968	2,417	58,597	1,877	8,706	6,168	648,438

W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding and/or concealment of confidential data.

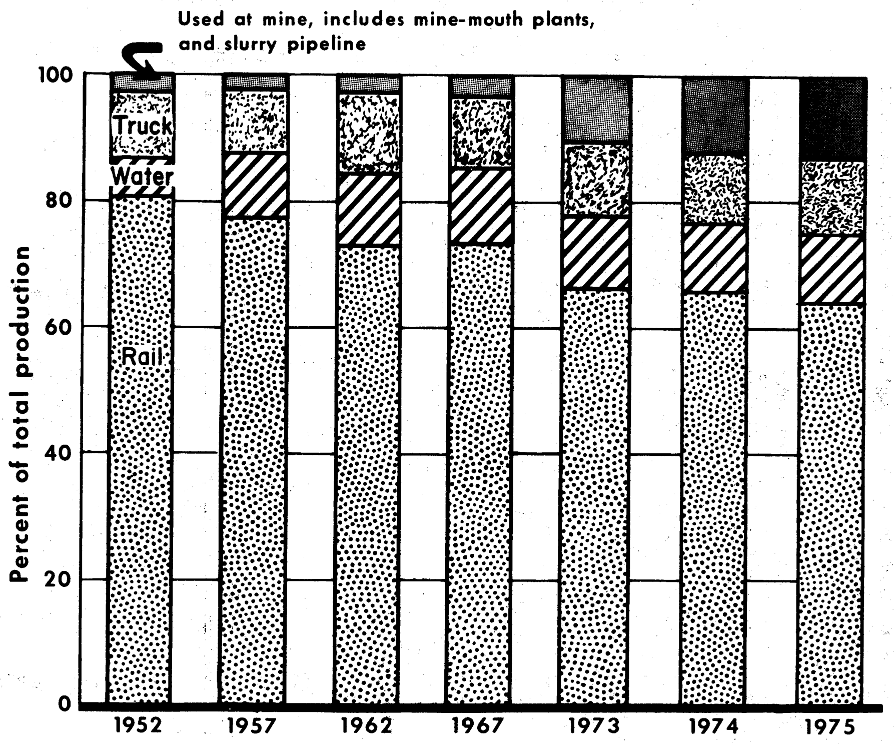

Figure 5.—Percentage of total production of bituminous coal and lignite, by method of shipment from mines and percentage used at mines.

Table 18.—Production, shipments, and value at bituminous coal and lignite mines, by State and county

(Thousand short tons)

State and county	Production								Shipments					Average value per ton [4]
	Underground		Strip		Auger		Strip-auger		Rail or water [1]	Truck	Mine-mouth generating plants	All other [2]	Total [3]	
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity						
Alabama:														
Bibb	--	--	4	285	--	--	--	--	279	6	--	--	285	$33.84
Blount	1	13	16	840	--	--	--	--	444	409	--	--	853	23.04
Cherokee	--	--	3	11	--	--	--	--	8	3	--	--	11	19.48
Cullman	--	--	20	592	--	--	--	--	162	429	--	--	592	23.48
De Kalb	--	--	12	447	--	--	--	--	--	427	--	20	447	26.66
Fayette	1	W	6	W	--	--	--	--	523	223	--	--	747	29.24
Franklin	--	--	3	15	--	--	--	--	--	15	--	--	15	21.69
Jackson	2	W	3	W	--	--	--	--	714	60	--	--	774	W
Jefferson	11	4,547	26	3,117	1	11	--	--	6,205	1,283	176	--	7,664	29.52
Lamar	--	--	1	3	--	--	--	--	--	3	--	--	3	22.75
Marion	1	10	23	557	--	--	--	--	266	301	--	--	567	22.94
St. Clair	--	--	4	49	--	--	--	--	13	35	--	--	49	19.00
Shelby	--	--	4	576	--	--	--	--	554	22	--	--	576	W
Tuscaloosa	--	--	23	2,578	--	--	--	--	1,735	343	--	500	2,578	24.55
Walker	4	2,582	46	3,974	--	--	--	--	3,476	1,233	1,847	--	6,556	25.55
Winston	--	--	21	928	--	--	--	--	154	774	--	--	928	21.49
Undistributed	--	463	--	1,046	--	--	--	--	--	--	--	--	--	--
Total [3]	20	7,614	215	[5] 15,018	1	11	--	--	14,533	5,568	2,023	520	22,644	26.53
Alaska: Yukon River	--	--	1	766	--	--	--	--	625	141	--	--	766	W
Arizona: Navajo	--	--	2	6,986	--	--	--	--	2,818	--	--	4,168	6,986	W
Arkansas:														
Franklin	--	--	2	W	--	--	--	--	W	--	--	W	W	W
Johnson	--	--	3	W	--	--	--	--	W	--	--	--	--	W
Logan	--	--	2	35	--	--	--	--	--	35	--	--	35	28.54
Sebastian	--	--	1	W	--	--	--	--	W	--	--	W	W	W
Undistributed	--	--	--	453	--	--	--	--	411	27	--	16	454	32.76
Total [3]	--	--	8	488	--	--	--	--	411	62	--	16	488	32.76
Colorado:														
Delta	(6)	W	--	--	--	--	--	--	W	--	--	W	W	W
Fremont	1	W	3	W	--	--	--	--	--	147	--	--	147	W
Garfield	1	1	--	--	--	--	--	--	--	1	--	--	1	W
Gunnison	4	1,070	--	--	--	--	--	--	1,042	20	--	8	1,070	35.70
Jackson	--	--	3	321	--	--	--	--	321	--	--	--	321	13.01
La Plata	1	W	--	--	--	--	--	--	--	W	--	--	W	W
Las Animas	1	632	--	--	--	--	--	--	632	--	--	--	632	30.00
Mesa	1	55	--	--	--	--	--	--	--	--	55	(7)	55	9.50
Moffat	1	W	1	W	--	--	--	--	W	--	--	W	W	W
Montrose	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Pitkin	5	W	1	W	--	--	--	--	W	--	--	--	W	W
Rio Blanco	1	4	--	--	--	--	--	--	--	4	--	--	4	12.84
Routt	1	19	6	3,980	--	--	--	--	3,322	25	652	--	3,999	8.52
Weld	1	W	--	--	--	--	--	--	W	W	--	--	W	W

Undistributed	--	1,667	--	472	--	--	--	--	1,804	131	--	56	1,990	W
Total [3]	18	3,446	15	4,773	--	--	--	--	7,121	328	706	64	8,219	16.53
Georgia:														
Chattooga	--	--	1	W	--	--	--	--	W	W	--	--	W	W
Dade	--	--	2	W	--	--	--	--	W	W	--	--	W	W
Undistributed	--	--	--	74	--	--	--	--	61	13	--	--	74	W
Total [3]	--	--	3	74	--	--	--	--	61	13	--	--	74	W
Illinois:														
Christian	1	W	--	--	--	--	--	--	W	W	W	W	W	W
Douglas	2	2,540	--	--	--	--	--	--	1,634	906	--	(7)	2,540	14.59
Franklin	3	W	--	--	--	--	--	--	W	--	--	W	W	W
Fulton	--	--	4	2,638	--	--	--	--	2,369	269	--	(7)	2,638	16.01
Gallatin	1	W	1	W	--	--	--	--	W	--	--	--	W	W
Jackson	--	--	2	55	--	--	--	--	55	--	--	--	55	12.72
Jefferson	3	W	1	W	--	--	--	--	5,843	141	--	26	6,011	W
Johnson	--	--	1	1	--	--	--	--	1	--	--	--	1	12.72
Knox	--	--	1	1,334	--	--	--	--	1,046	287	--	--	1,334	12.72
Macoupin	1	W	--	--	--	--	--	--	W	(7)	--	--	W	W
Montgomery	1	W	--	--	--	--	--	--	--	--	W	--	W	W
Peoria	--	--	2	W	--	--	--	--	W	W	--	W	W	W
Perry	--	--	5	11,675	--	--	--	--	11,301	364	--	11	11,675	11.42
Randolph	2	W	4	W	--	--	--	--	5,326	153	2,730	(7)	8,209	11.24
St. Clair	1	W	1	W	--	--	--	--	W	W	--	--	W	W
Saline	2	W	4	W	--	--	--	--	1,935	86	--	4	2,025	W
Stark	--	--	1	270	--	--	--	--	204	66	--	--	270	72
Vermilion	--	--	1	15	--	--	--	--	--	13	--	2	15	12.72
Wabash	1	W	--	--	--	--	--	--	W	--	--	--	W	W
Williamson	3	1,587	9	1,777	--	--	--	--	3,047	303	5	9	3,364	20.04
Undistributed	--	27,748	--	9,896	--	--		--	15,563	1,474	4,327	35	21,399	--
Total [3]	21	31,875	37	27,661	--	--	--	--	48,323	4,062	7,062	89	59,537	14.64
Indiana:														
Clay	--	--	6	1,102	--	--	--	--	498	601	--	4	1,102	W
Daviess	--	--	2	97	--	--	--	--	77	20	--	--	97	11.15
Dubois	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Fountain	--	--	1	40	--	--	--	--	--	40	--	--	40	15.44
Greene	--	--	2	W	--	--	--	--	W	W	--	--	W	W
Knox	--	--	2	W	--	--	--	--	W	W	1	--	W	W
Owen	--	--	1	11	--	--	--	--	--	11	--	--	11	11.15
Parke	--	--	2	4	--	--	--	--	--	4	--	--	4	11.15
Perry	--	--	1	10	--	--	--	--	--	10	--	--	10	11.15
Pike	1	W	13	W	--	--	--	--	4,016	1,516	--	29	5,560	13.84
Spencer	--	--	10	547	--	--	--	--	400	147	--	--	547	10.02
Sullivan	--	--	3	W	--	--	--	--	W	W	--	W	W	W
Vermillion	--	--	3	W	--	--	--	--	W	W	--	--	W	W
Vigo	--	--	1	34	--	--	--	--	--	34	--	--	34	11.15
Warrick	1	W	12	W	--	--	--	--	W	W	--	W	W	W
Undistributed	--	188	--	23,090	--	--	--	--	15,079	2,632	--	6	17,718	W
Total [3]	2	188	60	24,935	--	--	--	--	20,069	5,015	1	39	25,124	11.15
Iowa:														
Lucas	1	W	--	--	--	--	--	--	--	W	--	--	W	W
Mahaska	--	--	4	128	--	--	--	--	73	30	25	--	128	11.09
Marion	--	--	3	62	--	--	--	--	17	45	--	--	62	12.18

See footnotes at end of table.

Table 18.—Production, shipments, and value at bituminous coal and lignite mines, by State and county—Continued

(Thousand short tons)

State and county	Production								Shipments					Average value per ton [4]
	Underground		Strip		Auger		Strip-auger		Rail or water [1]	Truck	Mine-mouth generating plants	All other [2]	Total [3]	
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity						
Iowa—Continued														
Monroe	1	W	--	--	--	--	--	--	--	W	--	--	W	W
Wapello	--	--	1	69	--	--	--	--	--	69	--	--	69	$12.50
Undistributed	--	363	--	--	--	--	--	--	--	363	--	--	363	--
Total [3]	2	363	8	259	--	--	--	--	90	507	25	--	622	11.08
Kansas:														
Bourbon	--	--	1	46	--	--	--	--	46	--	--	--	46	W
Cherokee	--	--	1	98	--	--	--	--	--	94	--	4	98	W
Crawford	--	--	2	335	--	--	--	--	335	1	--	--	335	W
Total [3]	--	--	4	479	--	--	--	--	381	95	--	4	479	19.78
Kentucky, Eastern:														
Bell	23	890	15	2,235	4	99	26	700	3,757	167	--	(7)	3,924	20.41
Boyd	--	--	3	56	--	--	2	20	--	76	--	--	76	14.79
Breathitt	1	56	10	4,842	--	--	28	1,633	6,415	73	--	43	6,531	13.50
Carter	1	2	24	256	--	--	3	6	58	206	--	--	263	13.94
Clay	41	435	4	44	--	--	54	692	795	371	--	5	1,171	17.62
Elliott	--	--	9	316	--	--	15	158	278	195	--	--	473	14.75
Floyd	102	2,472	12	1,037	4	100	35	852	3,868	594	--	--	4,462	15.85
Greenup	--	--	9	143	--	--	3	39	79	103	--	--	182	16.45
Harlan	98	8,878	6	W	10	(5)	61	1,511	10,281	563	--	16	10,860	29.11
Jackson	1	2	14	226	1	6	20	287	238	256	--	27	521	14.73
Johnson	4	150	23	876	4	24	41	463	825	633	55	--	1,513	17.36
Knott	67	3,010	9	134	7	160	34	894	3,798	400	--	--	4,198	23.09
Knox	9	33	22	696	5	38	69	1,015	1,254	446	--	82	1,781	16.70
Laurel	9	128	17	415	2	89	72	931	1,092	419	--	53	1,564	16.13
Lawrence	--	--	10	373	4	57	22	421	570	262	20	(7)	851	15.15
Lee	1	10	7	74	--	--	9	104	65	123	--	--	187	15.28
Leslie	39	1,598	14	902	4	69	56	1,026	2,757	290	547	--	3,595	15.72
Letcher	85	3,356	8	238	14	138	46	1,180	4,314	589	--	9	4,912	22.98
McCreary	4	593	6	130	--	--	5	113	745	91	--	--	836	22.19
Magoffin	4	92	--	--	6	81	27	1,528	1,629	72	--	--	1,701	15.60
Martin	15	2,261	28	3,189	6	44	18	1,378	6,518	354	--	--	6,872	13.65
Menifee	--	--	1	7	--	--	--	--	--	7	--	--	7	14.65
Morgan	--	--	20	666	1	21	17	421	892	162	53	--	1,107	14.16
Owsley	1	2	9	181	--	--	11	119	252	51	--	--	303	15.54
Perry	38	1,990	11	1,226	13	372	49	2,813	5,960	393	--	47	6,400	17.52
Pike	303	14,277	24	919	15	326	88	3,656	17,817	1,295	--	67	19,178	27.02
Pulaski	2	W	3	W	--	--	5	128	409	54	--	--	463	17.65
Rockcastle	1	8	1	6	--	--	5	60	--	74	--	--	74	15.86
Wayne	1	W	2	W	1	(5)	5	78	141	63	8	--	211	12.66
Whitley	19	328	20	636	1	12	68	1,882	2,123	671	58	6	2,858	16.80
Wolfe	--	--	6	140	--	--	7	42	--	132	50	--	182	14.77
Undistributed	1	58	--	698	--	184	--	--	--	--	--	--	--	--
Total [3]	869	40,628	347	20,656	102	1,822	901	24.150	76,929	9,183	791	354	87,257	20.79

Kentucky, Western:														
Butler	1	W	27	W	--	--	4	W	91	641	--	--	731	16.30
Christian	--	--	3	199	--	--	--	--	185	14	--	--	199	13.44
Daviess	--	--	1	W	--	--	--	--	W	W	--	39	W	W
Edmonson	--	--	3	34	--	--	--	--	--	34	--	--	34	10.66
Grayson	--	--	3	40	--	--	--	--	--	40	--	--	40	10.66
Hancock	--	--	2	261	--	--	--	--	--	261	--	--	261	10.66
Henderson	2	W	--	--	--	--	--	--	--	--	W	--	W	W
Hopkins	9	5,490	32	4,260	--	--	3	63	9,664	149	--	(7)	9,813	13.88
McLean	--	--	5	856	--	--	--	--	836	20	--	--	856	10.66
Muhlenberg	5	5,194	15	17,262	--	--	--	--	15,652	W	W	--	22,456	10.67
Ohio	3	W	38	6,332	--	--	1	W	9,885	194	--	--	10,079	11.84
Union	6	W	--	--	--	--	--	--	W	--	--	--	W	W
Warren	--	--	1	2	--	--	--	--	--	2	--	--	2	10.66
Webster	1	1,748	16	256	--	--	1	3	1,822	185	--	--	2,007	26.24
Undistributed	--	12.573	--	1,520	--	--	--	264	7,988	728	7,927	--	9,878	--
Total [3]	27	25,004	146	31,022	--	--	9	331	46,123	2,268	7,928	39	56,357	12.16
Total Kentucky	896	65,632	493	51,678	102	1,822	910	24,481	123.051	11,451	8,718	393	143,613	17.40
Maryland:														
Allegheny	--	--	27	934	4	18	--	--	432	519	--	--	952	20.59
Garrett	2	104	34	1,532	2	18	--	--	1,147	507	--	--	1,654	18.68
Total [3]	2	104	61	2,466	6	36	--	--	1,579	1,027	--	--	2,606	19.38
Missouri:														
Barton	--	--	1	563	--	--	--	--	--	--	563	--	563	W
Bates	--	--	1	W	--		--	--	--	--	W	--	W	W
Henry	--	--	2	W	--	--	--	--	W	W	W	--	W	W
Howard	--	--	1	3	--	--	--	--	--	3	--	--	3	17.14
Macon	--	--	1	W	--	--	--	--	W	--	--	--	W	W
Putnam	--	--	1	353	--	--	--	--	306	47	--	--	353	13.00
Randolph	--	--	3	W	1	76	--	--	--	W	W	2	W	W
Vernon	--	--	2	242	--	--	--	--	242	--	--	--	242	W
Undistributed	--	--	--	4,404	--	--	--	--	1.226	30	3,219	--	4,477	--
Total [3]	--	--	12	5,562	1	76	--	--	1,775	79	3,783	2	5,638	8.52
Montana (bituminous):														
Big Horn	--	--	2	W	--	--	--	--	W	--	--	--	W	W
Musselshell	--	--	2	W	--	--	--	--	--	W	--	--	W	W
Rosebud	--	--	2	W	--	--	--	--	W	W	268	--	W	W
Undistributed	--	--	--	21,752	--	--	--	--	21,466	17	--	--	21,752	--
Total	--	--	6	21,752	--	--	--	--	21,466	17	268	--	21,752	5.06
Montana (lignite):														
Powder River	--	--	1	1	--	--	--	--	--	1	--	--	1	W
Richland	--	--	1	301	--	--	--	--	300	1	--	--	301	W
Total	--	--	2	302	--	--	--	--	300	2	--	--	302	W
Total Montana	--	--	8	22,054	--	--	--	--	21.766	20	268	--	22,054	5.06
New Mexico:														
Colfax	1	764	1	253	--	--	--	--	1,016	--	--	--	1,016	W
McKinley	--	--	1	468	--	--	--	--	466	--	--	2	468	W
San Juan	--	--	2	7,301	--	--	--	--	--	--	7,301	--	7.301	W
Total [3]	1	764	4	8.022	--	--	--	--	1,482	--	7,301	2	8,785	W

See footnotes at end of table.

Table 18.—Production, shipments, and value at bituminous coal and lignite mines, by State and county—Continued

(Thousand short tons)

State and county	Production								Shipments					
	Underground		Strip		Auger		Strip-auger		Rail or water [1]	Truck	Mine-mouth generating plants	All other [2]	Total [3]	Average value per ton [4]
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity						
North Dakota:														
Bowman	--	--	1	W	--	--	--	--	W	W	--	--	W	W
Burke	--	--	1	W	--	--	--	--	W	W	--	--	W	W
Grant	--	--	1	4	--	--	--	--	--	1	--	4	4	$6.75
Mercer	--	--	3	3,743	--	--	--	--	1,687	--	2,040	16	3,743	3.45
Oliver	--	--	1	W	--	--	--	--	W	--	W	--	W	W
Stark	--	--	1	142	--	--	--	--	--	141	--	1	142	2.50
Ward	--	--	1	W	--	--	--	--	W	--	W	--	W	W
Williams	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Undistributed	--	--	--	4,628	--	--	--	--	2,659	169	1,797	--	4,627	--
Total [3]	--	--	10	8,515	--	--	--	--	4,347	311	3,837	20	8,515	3.17
Ohio:														
Athens	--	--	3	128	--	--	--	--	69	59	--	--	128	8.39
Belmont	7	6,150	33	5,347	2	(5)	11	W	14,316	966	--	--	15,282	16.40
Carroll	--	--	4	235	--	--	--	--	--	214	21	--	235	15.95
Columbiana	4	39	23	486	3	40	7	249	106	574	134	1	814	16.29
Coshocton	1	W	17	2,220	2	(5)	--	--	378	1,177	1,354	--	2,909	19.78
Gallia	--	--	4	331	--	--	--	--	134	50	147	(7)	331	11.46
Guernsey	1	29	9	1,115	--	--	--	--	1,009	133	--	2	1,143	15.59
Harrison	5	2,959	18	1,737	1	7	4	1,944	6,421	186	41	--	6,647	16.63
Hocking	--	--	7	480	--	--	--	--	--	426	54	--	480	12.12
Holmes	--	--	4	671	--	--	--	--	69	602	--	--	671	12.32
Jackson	3	67	18	611	--	--	--	--	210	467	--	1	677	16.05
Jefferson	2	662	36	3,351	8	124	--	--	1,844	2,272	--	21	4,137	17.84
Lawrence	--	--	4	149	--	--	--	--	133	8	--	7	149	14.07
Mahoning	--	--	9	412	--	--	--	--	--	412	--	--	412	18.83
Meigs	2	W	--	--	--	--	--	--	--	--	W	--	W	W
Monroe	2	1,115	--	--	--	--	--	--	1,115	--	--	--	1,115	19.93
Morgan	--	--	1	W	--	--	--	--	--	--	W	--	W	W
Muskingum	2	W	16	3,043	3	(5)	--	--	51	840	2,282	--	3,173	15.21
Noble	--	--	4	489	--	--	--	--	87	W	W	--	489	13.81
Perry	1	W	8	W	--	--	--	--	1,735	760	--	(7)	2,495	12.92
Stark	--	--	13	461	--	--	--	--	--	451	--	10	461	15.36
Tuscarawas	1	W	24	1,443	6	115	1	W	232	1,351	--	6	1,589	17.24
Vinton	2	W	10	W	--	--	--	--	537	1,140	--	--	1,677	13.10
Washington	--	--	1	76	--	--	--	--	--	76	--	--	76	15.49
Wayne	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Undistributed	--	4,433	--	2,126	--	207	--	3,720	--	430	1,650	--	1,678	--
Total [3]	33	15,455	267	24,908	25	495	23	5,912	28,446	12,592	5,683	49	46,770	16.40
Oklahoma:														
Craig	--	--	4	1,275	--	--	--	--	1,113	162	--	(7)	1,275	10.45
Haskell	--	--	7	276	--	--	--	--	239	37	--	1	276	33.40
Le Flore	--	--	7	288	--	--	--	--	271	17	--	--	288	38.40
Muskogee	--	--	2	120	--	--	--	--	118	3	--	--	120	16.29

Nowata	--	--	3	34	--	--	--	--	9	25	--	--	34	14.52
Okmulgee	--	--	1	89	--	--	--	--	60	28	--	--	89	11.99
Pittsburg	--	--	1	120	--	--	--	--	120	--	--	--	120	11.99
Rogers	--	--	6	671	--	--	--	--	665	6	--	--	671	14.00
Total [3]	--	--	31	2,872	--	--	--	--	2,594	277	--	1	2,872	16.69
Pennsylvania:														
Allegheny	7	3,293	16	664	--	--	--	--	2,722	1,215	11	10	3,957	26.73
Armstrong	12	4,076	64	2,977	9	88	3	48	1,865	2,125	3,060	139	7,189	17.61
Beaver	1	157	5	30	--	--	--	--	8	179	--	--	187	24.60
Bedford	--	--	2	W	--	--	--	--	--	W	--	1	W	W
Blair	--	--	2	W	--	--	--	--	--	W	--	--	W	W
Butler	1	W	21	1,109	4	(5)	--	--	795	576	--	3	1,373	19.71
Cambria	18	5,623	22	1,766	--	--	--	--	5,784	1,554	48	4	7,390	36.24
Centre	1	W	12	W	--	--	--	--	886	579	--	5	1,469	21.73
Clarion	--	--	51	5,324	1	12	--	--	3,805	1,486	17	28	5,336	17.08
Clearfield	4	W	90	7,380	1	(5)	--	--	4,412	3,605	--	108	8,124	20.40
Clinton	--	--	7	433	--	--	--	--	100	334	--	--	433	19.57
Elk	--	--	14	651	4	31	--	--	247	435	--	--	682	16.37
Fayette	3	W	62	W	--	--	--	--	2,180	620	8	9	2,816	20.94
Fulton	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Greene	15	7,175	25	880	--	--	--	--	7,377	670	--	9	8,055	33.27
Huntingdon	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Indiana	27	7,860	52	2,363	8	89	--	--	4,542	1,564	4,177	29	10,312	19.20
Jefferson	4	W	42	2,014	3	(5)	--	--	1,376	747	--	24	2,147	20.23
Lawrence	--	--	17	W	2	(5)	--	--	107	274	135	47	564	16.52
Lycoming	--	--	3	W	--	--	--	--	--	W	--	--	W	W
Mercer	--	--	3	336	--	--	--	--	138	153	--	46	336	22.21
Somerset	21	2,091	67	3,889	6	44	--	--	3,709	2,193	--	122	6,024	26.85
Tioga	--	--	2	W	--	--	--	--	--	W	--	--	W	W
Venango	--	--	10	451	--	--	--	--	42	410	--	--	451	16.06
Washington	13	10,974	26	2,386	1	1	--	--	11,170	2,180	--	10	13,360	32.21
Westmoreland	5	960	44	1,886	--	--	--	--	1,112	1,721	--	13	2,846	25.93
Undistributed	--	2,422	--	4,564	--	90	--	--	--	1,084	--	--	1,084	--
Total [3]	132	44,631	661	39,105	39	354	3	48	52,375	23,702	7,456	605	84,137	25.09
Tennessee:														
Anderson	20	1,132	9	W	3	(5)	--	--	474	1,234	40	100	1,848	16.08
Bledsoe	--	--	3	W	--	--	--	--	W	W	--	--	W	W
Campbell	12	435	20	W	2	(5)	1	17	1,471	231	--	--	1,703	19.33
Claiborne	3	W	5	W	--	--	--	--	1,226	3	--	1	1,230	W
Cumberland	--	--	2	51	--	--	--	--	--	51	--	--	51	17.62
Fentress	--	--	6	216	--	--	--	--	63	148	--	4	216	15.77
Grundy	--	--	7	101	--	--	--	--	17	84	--	--	101	18.58
Marion	7	W	1	W	--	--	--	--	367	103	--	--	470	15.72
Morgan	1	13	10	544	2	19	--	--	219	356	--	--	576	16.30
Overton	1	W	1	W	--	--	--	--	--	W	--	--	W	W
Putnam	1	W	--	--	--	--	--	--	--	W	--	--	W	W
Roane	--	--	--	--	1	(5)	--	--	--	W	--	--	W	W
Scott	8	282	25	W	1	(5)	--	--	1,026	60	--	--	1,087	17.18
Sequatchie	8	W	2	W	--	--	--	--	474	131	--	--	605	19.68
Van Buren	1	1	1	25	--	--	--	--	25	1	--	--	26	16.00
White	--	--	2	W	--	--	--	--	W	W	--	--	W	W

See footnotes at end of table.

Table 18.—Production, shipments, and value at bituminous coal and lignite mines, by State and county—Continued

(Thousand short tons)

State and county	Production								Shipments					
	Underground		Strip		Auger		Strip-auger		Rail or water [1]	Truck	Mine-mouth generating plants	All other [2]	Total [3]	Average value per ton [4]
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity						
Tennessee—Continued														
Undistributed	--	1,944	--	3,294	--	133	--	--	76	217	--	--	293	--
Total [3]	62	3,806	94	4,231	9	152	1	17	5,440	2,621	40	105	8,206	$17.10
Texas:														
Freestone	--	--	1	W	--	--	--	--	--	--	W	W	W	W
Harrison	--	--	1	W	--	--	--	--	--	W	--	--	W	W
Milam	--	--	1	W	--	--	--	--	--	W	--	W	W	W
Titus	--	--	1	W	--	--	--	--	--	--	W	--	W	W
Undistributed	--	--	--	11,002	--	--	--	--	--	268	8,934	1,800	11,002	W
Total [3]	--	--	4	11,002	--	--	--	--	--	268	8,934	1,800	11,002	W
Utah:														
Carbon	12	3,089	--	--	--	--	--	--	W	W	--	W	W	26.35
Emery	7	W	--	--	--	--	--	--	W	W	W	W	W	W
Sevier	1	W	--	--	--	--	--	--	W	W	W	--	W	W
Undistributed	--	3,872	--	--	--	--	--	--	5,032	748	1,065	116	6,961	--
Total [3]	20	6,961	--	--	--	--	--	--	5,032	748	1,065	116	6,961	19.84
Virginia:														
Buchanan	225	10,126	69	2,656	25	502	10	731	11,410	2,606	--	--	14,016	32.15
Dickenson	56	4,115	42	W	--	--	2	W	4,887	470	--	--	5,357	33.99
Lee	18	W	9	W	--	--	8	418	959	118	--	--	1,077	28.14
Russell	6	W	9	474	--	--	5	W	1,868	217	--	--	2,085	34.36
Tazewell	22	2,177	10	218	4	(5)	2	W	2,092	449	--	2	2,542	28.27
Wise	47	4,854	166	4,649	1	(5)	9	W	9,167	1,264	--	2	10,433	26.37
Undistributed	--	1,909	--	1,149	--	33	--	1,498	--	--	--	--	--	--
Total [3]	374	23,181	305	9,145	30	536	36	2,648	30,381	5,125	--	3	35,510	30.46
Washington:														
King	1	13	1	5	--	--	--	--	--	17	--	--	17	20.02
Lewis	--	--	2	2,238	--	--	--	--	--	8	2,231	--	2,238	W
Thurston	--	--	(6)	[6] 1,487	--	--	--	--	--	--	1,487	--	1,487	W
Total [3]	1	13	3	3,730	--	--	--	--	--	25	3,718	--	3,743	W
West Virginia:														
Barbour	13	W	14	1,854	--	--	3	W	3,519	153	--	--	3,672	22.33
Boone	53	7,885	20	1,722	--	--	2	68	9,454	214	--	6	9,675	30.94
Braxton	6	W	1	W	--	--	1	14	86	3	--	--	88	21.83
Brooke	2	W	4	W	--	--	--	--	588	142	--	10	741	W
Clay	3	68	--	--	--	--	--	--	68	--	--	--	68	28.62
Fayette	31	2,277	12	W	--	--	2	W	2,855	72	--	2	2,929	34.06
Gilmer	2	W	1	W	--	--	--	--	111	8	--	--	119	23.59
Grant	4	1,458	9	343	--	--	--	--	1,250	298	252	--	1,800	13.52

Greenbrier	10	313	13	533	--	--	--	--	843	3	--	--	846	41.95
Harrison	9	3,295	31	795	--	--	1	361	2,044	172	2,235	--	4,451	17.43
Kanawha	45	5,431	22	1,633	--	--	9	814	7,438	434	--	6	7,878	24.31
Lewis	3	50	19	664	--	--	--	--	684	30	--	--	714	19.79
Lincoln	2	W	--	--	--	--	--	--	W	--	--	--	W	W
Logan	86	7,222	9	577	--	--	4	350	7,754	394	--	--	8,148	31.18
McDowell	102	10,112	11	664	--	--	3	112	10,586	241	--	62	10,888	44.45
Marion	8	5,484	3	30	--	--	--	--	5,470	20	22	2	5,514	25.74
Marshall	4	5,266	--	--	--	--	--	--	2,038	64	3,164	--	5,266	13.16
Mason	2	295	--	--	--	--	--	--	--	113	182	--	295	W
Mercer	4	971	2	11	--	--	1	18	996	--	--	3	999	W
Mineral	1	W	11	W	--	--	--	--	326	31	--	--	357	11.15
Mingo	54	4,166	8	466	--	--	1	89	4,555	166	--	1	4,721	26.12
Monongalia	18	10,090	7	W	--	--	1	W	10,834	226	--	10	11,070	19.55
Nicholas	54	4,352	17	1,014	--	--	5	238	5,573	32	--	--	5,605	33.78
Ohio	2	W	--	--	--	--	--	--	W	93	--	23	W	W
Preston	16	811	40	1,747	--	--	--	--	884	1,654	20	(7)	2,559	20.42
Raleigh	38	5,252	17	W	--	--	1	W	5,990	193	--	39	6,222	44.24
Randolph	17	212	13	W	1	(5)	--	--	884	35	--	--	920	22.52
Summers	3	82	--	--	--	--	--	--	82	--	--	--	82	17.50
Taylor	--	--	9	171	--	--	--	--	171	--	--	--	171	18.56
Tucker	--	--	7	357	--	--	--	--	357	--	--	--	357	24.11
Upshur	4	957	13	850	--	--	3	192	1,913	85	--	--	1,998	24.77
Wayne	2	548	--	--	--	--	--	--	462	86	--	--	548	28.74
Webster	16	174	5	262	--	--	1	5	437	5	--	--	442	24.69
Wyoming	89	8,195	5	175	2	(5)	5	W	8,375	259	40	20	8,694	40.93
Undistributed	--	3,391	--	2,977	--	46	--	1,772	1,330	--	--	--	1,445	--
Total [3]	703	88,357	323	16,846	3	46	43	4,034	97,958	5,225	5,915	185	109,283	29.35
Wyoming:														
Campbell	--	--	2	W	--	--	--	--	W	W	W	1	W	W
Carbon	3	310	6	10,668	--	--	--	--	10,975	--	--	3	10,978	8.28
Converse	--	--	1	W	--	--	--	--	--	--	W	--	W	W
Hot Springs	1	W	1	W	--	--	--	--	W	W	--	--	W	W
Lincoln	--	--	2	W	--	--	--	--	W	--	W	--	W	W
Sheridan	--	--	2	W	--	--	--	--	W	W	--	--	W	W
Sweetwater	1	W	1	W	--	--	--	--	W	(7)	W	106	W	W
Undistributed	--	126	--	12,701	--	--	--	--	5,609	104	7,006	--	12,827	--
Total	5	436	15	23,369	--	--	--	--	16,584	105	7,006	110	23,804	6.74
Total United States [3]	2,292	292,826	2,644	314,945	216	3,526	1,016	37,141	487,243	79,365	73,543	8,288	648,438	19.23

W Withheld to avoid disclosing individual company confidential data.
[1] Includes coal loaded at mine directly into railroad cars or river barges, hauled by trucks to railroad sidings, and hauled by trucks to waterways.
[2] Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for all other purposes at mine and shipped by slurry pipeline in Arizona.
[3] Data may not add to totals shown because of independent rounding.
[4] Value at average prices that might have been received if such coal had been sold commercially.
[5] Auger production included with strip production figure to avoid disclosing individual company data.
[6] One mine extends into two counties but is counted only in the county where its greater production occurred.
[7] Less than 500 tons.

Table 19.—Production, method of operation, and equipment at underground bituminous coal mines, by State, in 1975

(Thousand short tons)

State	Number of mines	Production	Cut by hand or shot from solid	Cut by machines: Quantity	Cut by machines: Number of coal cutting machines	Cut by machines: Average output per machine	Mined by continuous-mining machines	Mined by longwall machines
Alabama	20	7,614	32	5,014	51	98	2,569	--
Colorado	18	3,446	1	41	4	10	3,195	209
Illinois	21	31,875	--	7,198	35	206	24,677	--
Indiana	2	188	--	188	2	94	--	--
Iowa	2	363	--	363	2	182	--	--
Kentucky:								
Eastern	869	40,628	2,855	17,397	481	36	20,138	238
Western	27	25,004	--	24,237	116	209	767	--
Total	896	65,632	2,855	41,634	597	70	20,905	238
Maryland	2	104	--	--	--	--	104	--
New Mexico	1	764	--	--	--	--	372	391
Ohio	33	15,455	--	5,309	50	106	10,146	--
Pennsylvania	132	44,631	2	1,036	37	28	40,511	3,081
Tennessee	62	3,806	11	2,153	57	38	1,641	--
Utah	20	6,961	--	943	8	118	5,261	757
Virginia	374	23,181	1,383	6,892	214	32	13,875	1,032
Washington	1	13	13	--	--	--	--	--
West Virginia	703	88,357	152	22,600	533	42	62,201	3,405
Wyoming	5	436	--	291	5	58	145	--
Total	2,292	292,826	4,449	93,662	1,595	59	185,602	9,113

	Power drills									
	Face or coal drills				Roof or rock drills					
	Handheld or post mounted		Mobile		Roof bolting			Other uses		
	Number	Quantity	Number	Quantity	Rotary	Percussion	Rotary percussion	Rotary	Percussion	Rotary percussion
Alabama	14	532	44	4,514	73	2	6	--	--	--
Colorado	4	38	1	4	37	--	--	--	2	7
Illinois	--	--	35	7,198	236	2	--	--	--	--
Indiana	--	--	2	188	3	--	--	--	--	--
Iowa	--	--	2	363	2	--	--	--	--	--
Kentucky:										
Eastern	596	8,229	252	11,699	557	29	50	3	--	4
Western	2	43	117	24,194	265	--	--	4	--	--
Total	598	8,272	369	35,893	822	29	50	7	--	4
Maryland	--	--	--	--	1	--	1	--	--	--
New Mexico	--	--	--	--	6	--	--	--	--	--
Ohio	17	1,168	35	4,140	261	7	1	--	--	--
Pennsylvania	27	348	11	690	379	153	173	--	--	--
Tennessee	55	1,174	19	990	40	--	2	--	--	--
Utah	--	--	7	943	26	16	17	--	--	--
Virginia	199	3,970	104	4,176	317	60	2	--	--	--
Washington	2	13	--	--	--	--	--	--	--	--
West Virginia	315	6,683	292	16,068	753	101	94	--	--	--
Wyoming	1	1	4	289	7	--	3	--	--	--
Total	1,232	22,199	[1] 929	75,456	2,963	370	349	7	2	11

[1] Data do not add to total shown because of independent rounding.

Table 20.—Haulage units at underground bituminous coal mines, by State, in 1975

State	Railroad: Locomotives: Trolley	Railroad: Locomotives: Battery	Railroad: Mine cars	Rubber-tired vehicles: Tractors	Rubber-tired vehicles: Trailers	Rubber-tired vehicles: Shuttle cars: Cable reel	Rubber-tired vehicles: Shuttle cars: Battery	Rubber-tired vehicles: Shuttle buggies	Gathering and haulage conveyors: Units	Gathering and haulage conveyors: Miles
Alabama	115	--	1,787	71	--	158	31	2	134	55.1
Colorado	32	3	1,037	9	--	97	5	1	45	10.9
Illinois	55	34	87	107	56	451	16	--	337	163.3
Indiana	1	--	16	--	--	6	--	--	2	.8
Iowa	6	--	51	--	--	4	--	--	--	--
Kentucky:										
Eastern	207	28	4,478	536	9	1,055	201	125	942	207.1
Western	41	17	198	103	--	287	8	--	204	85.2
Total	248	45	4,676	639	9	1,342	209	125	1,146	292.3
Maryland	--	--	--	--	--	4	--	--	3	.6
New Mexico	--	--	--	--	--	10	--	--	10	5.7
Ohio	122	25	2,323	76	19	293	35	2	222	72.8
Pennsylvania	993	52	11,097	345	--	1,092	37	13	798	320.1
Tennessee	21	--	142	88	107	66	12	3	97	28.1
Utah	60	--	857	52	7	122	12	--	148	48.8
Virginia	188	8	2,070	376	849	456	120	58	555	192.3
Washington	1	--	10	--	--	1	--	--	--	--
West Virginia	1,123	294	19,748	616	661	2,253	221	21	1,681	534.5
Wyoming	1	--	20	9	--	17	--	3	9	1.8
Total	2,966	461	43,921	2,388	1,708	6,372	698	228	5,187	1,727.1

Table 21.—Number and production of underground bituminous coal mines using gathering and haulage conveyors, and number and length of units in use, by State

State	Number of mines		Production (thousand short tons)		Number of units in use [1]		Average length (feet)		Total length (miles)	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Alabama	15	16	7,024	7,504	133	134	2,146	2,172	54.1	55.1
Colorado	19	13	3,223	2,615	51	45	1,641	1,280	15.9	10.9
Illinois	22	20	31,156	31,775	331	337	2,704	2,558	169.5	163.3
Indiana	--	1	--	99	--	2	--	2,000	--	.8
Iowa	--	--	--	--	--	--	--	--	--	--
Kentucky:										
Eastern	359	449	32,832	32,320	897	942	1,273	1,161	216.3	207.1
Western	29	27	22,988	25,004	210	204	2,002	2,205	79.6	85.2
Total	388	476	55,820	57,324	1,107	1,146	1,411	1,347	295.9	292.3
Maryland	1	2	90	104	2	3	500	1,000	.2	.6
New Mexico	1	1	529	764	12	10	3,000	3,000	6.8	5.7
Ohio	21	26	13,981	15,360	186	222	1,895	1,731	66.8	72.8
Pennsylvania	89	91	30,805	28,603	738	798	2,012	2,118	281.2	320.1
Tennessee	21	44	2,305	3,806	64	97	1,466	1,529	17.8	28.1
Utah	14	19	5,676	6,891	96	148	1,420	1,741	25.8	48.8
Virginia	194	148	18,517	18,959	618	555	1,814	1,830	212.3	192.3
West Virginia	447	565	76,663	81,375	1,546	1,681	1,617	1,679	473.5	534.5
Wyoming	3	5	520	380	8	9	1,313	1,078	2.0	1.8
Total	1,235	1,427	246,309	255,559	4,892	5,187	r 1,750	1,758	1,621.8	1,727.1

r Revised.
[1] Includes all mines using belt conveyors 500 feet long or more for transporting coal underground.

Table 22.—Bituminous coal mechanically loaded underground in the United States, by type of loading equipment

(Thousand short tons)

Type of loading equipment	1974	1975
Mobile loading machines:		
Direct into mine cars or onto conveyors	7,173	5,036
Into shuttle cars	81,991	86,030
Continuous-mining machines:		
Onto conveyors	7,766	9,414
Into shuttle or mine cars	141,968	155,929
Onto bottom	21,563	20,261
Longwall machines	9,574	9,112
Scoops	6,564	6,536
Total	276,599	[1] 292,317

[1] Data do not add to total shown because of independent rounding.

Table 23.—Comparative changes in underground mechanical loading of bituminous coal by principal types of loading devices in the United States, by State

(Thousand short tons)

State	Mobile loading machines		Continuous-mining machines		Longwall machines		Scoops		Total mechanically loaded [1]	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Alabama	5,527	5,039	1,497	2,569	--	--	--	--	7,024	7,607
Colorado	22	38	3,039	3,195	180	209	5	--	3,246	3,442
Illinois	6,616	7,198	24,640	24,677	--	--	--	--	31,256	31,875
Indiana	139	188	--	--	--	--	--	--	139	188
Iowa	379	363	--	--	--	--	--	--	379	363
Kentucky:										
Eastern	16,863	16,589	18,870	20,138	235	238	4,187	3,407	40,155	40,372
Western	22,213	24,237	759	767	--	--	16	--	22,988	25,004
Total [1]	39,076	40,826	19,630	20,906	235	238	4,203	3,407	63,143	65,376
Maryland	--	--	90	104	--	--	--	--	90	104
New Mexico	--	--	346	372	183	391	--	--	529	764
Ohio	4,833	5,300	9,532	10,146	--	--	--	--	14,365	15,446
Pennsylvania	1,233	937	37,683	40,511	3,262	3,081	--	6	42,177	44,536
Tennessee	1,660	1,912	1,112	1,641	--	--	295	245	3,068	3,799
Utah	98	147	4,582	5,261	812	757	366	795	5,858	6,961
Virginia	7,417	6,886	12,393	13,875	1,592	1,032	1,239	1,284	22,641	23,077
Washington	15	13	--	--	--	--	--	--	15	13
West Virginia	22,094	21,928	56,285	62,201	3,312	3,405	456	799	82,147	88,332
Wyoming	54	289	469	145	--	--	--	--	523	434
Total [1]	89,164	91,065	171,297	185,602	9,574	9,113	6,564	6,536	276,599	292,317

[1] Data may not add to totals shown because of independent rounding.

Table 24.—Number of loading units used in bituminous coal underground mines, by State

State	Mobile loading machines		Continuous-mining machines		Longwall machines		Scoops		Total	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Alabama	62	57	23	28	--	--	--	--	85	85
Colorado	11	9	34	31	2	2	4	--	51	42
Illinois	41	35	138	157	--	--	--	--	179	192
Indiana	2	3	--	--	--	--	--	--	2	3
Iowa	3	2	--	--	--	--	--	--	3	2
Kentucky:										
Eastern	378	499	218	235	1	1	381	346	978	1,081
Western	118	128	5	6	--	--	1	--	124	134
Total	496	627	223	241	1	1	382	346	1,102	1,215
Maryland	--	--	1	2	--	--	--	--	1	2
New Mexico	5	5	5	5	1	2	--	--	11	12
Ohio	45	50	100	121	--	--	--	--	145	171
Pennsylvania	43	34	442	476	15	15	--	2	500	527
Tennessee	30	42	17	29	--	--	17	20	64	91
Utah	4	6	38	48	3	3	5	7	50	64
Virginia	233	206	202	213	10	8	97	104	542	531
Washington	1	1	--	--	--	--	--	--	1	1
West Virginia	630	640	730	846	21	19	38	100	1,419	1,605
Wyoming	2	4	6	2	--	--	--	--	8	6
Total	1,608	1,721	1,959	2,199	53	50	543	579	4,163	4,549

Table 25.—Production at underground bituminous coal mines, by State and method of loading

(Thousand short tons)

State	Hand-loaded		Mechanically loaded		Total [1]	
	1974	1975	1974	1975	1974	1975
Alabama	29	7	7,024	7,607	7,053	7,614
Colorado	14	4	3,246	3,442	3,260	3,446
Illinois	--	--	31,256	31,875	31,256	31,875
Indiana	--	--	139	188	139	188
Iowa	--	--	379	363	379	363
Kentucky:						
Eastern	354	256	40,155	40,372	40,509	40,628
Western	--	--	22,988	25,004	22,988	25,004
Total [1]	354	256	63,143	65,376	63,497	65,632
Maryland	--	--	90	104	90	104
New Mexico	--	--	529	764	529	764
Ohio	--	9	14,365	15,446	14,365	15,455
Pennsylvania	72	95	42,177	44,536	42,249	44,631
Tennessee	38	7	3,068	3,799	3,106	3,806
Utah	--	--	5,858	6,961	5,858	6,961
Virginia	127	104	22,641	23,077	22,767	23,181
Washington	--	--	15	13	15	13
West Virginia	73	25	82,147	88,332	82,220	88,357
Wyoming	3	1	523	434	526	436
Total [1]	710	508	276,599	292,317	277,309	292,826

[1] Data may not add to totals shown because of independent rounding.

Table 26.—Number and production of bituminous coal and lignite strip mines and units of stripping and loading equipment, in 1975, by State

State	Number of strip mines	Production (thousand short tons)	Number of power shovels and dragline excavators							
			By type of power				By capacity of dipper or bucket, cubic yards			
			Electric	Diesel electric	Diesel	Gasoline	Less than 6	6–15	16–50	More than 50
Alabama	215	15,018	29	67	127	--	113	76	30	4
Alaska	1	766	--	--	--	--	--	--	--	--
Arizona	2	6,986	6	--	1	--	--	4	2	1
Arkansas	8	488	1	--	9	--	2	5	3	--
Colorado	15	4,773	8	--	8	--	4	11	1	--
Georgia	3	74	--	--	2	--	--	2	--	--
Illinois	37	27,661	70	9	31	3	31	41	19	22
Indiana	60	24,935	72	10	88	--	99	41	17	13
Iowa	8	259	--	--	12	--	12	--	--	--
Kansas	4	479	4	--	3	--	3	4	--	--
Kentucky:										
Eastern	347	20,656	2	2	63	5	52	18	2	--
Western	146	31,022	60	7	109	--	102	43	20	11
Total	493	51,678	62	9	172	5	154	61	22	11
Maryland	61	2,466	--	1	80	1	63	19	--	--
Missouri	12	5,562	14	3	13	--	10	8	9	3
Montana:										
Bituminous	6	21,752	12	--	--	--	--	3	7	2
Lignite	2	302	1	--	2	--	2	1	--	--
Total	8	22,054	13	--	2	--	2	4	7	2
New Mexico	4	8,022	6	--	1	--	--	1	6	--
North Dakota (lignite)	10	8,515	13	2	10	1	9	9	7	1
Ohio	267	24,908	24	23	278	3	238	74	12	4
Oklahoma	31	2,872	8	3	18	--	15	8	6	--
Pennsylvania	661	39,105	14	27	910	9	654	296	10	--
Tennessee	94	4,231	--	1	54	--	45	10	--	--
Texas (lignite)	4	11,002	12	2	2	--	3	3	6	4
Virginia	305	9,145	--	--	82	--	80	2	--	--
Washington	3	3,730	5	--	1	--	1	--	3	2
West Virginia	323	16,846	1	--	249	2	214	37	1	--
Wyoming	15	23,369	24	1	8	1	9	11	11	3
Total [1]	2,644	314,945	386	158	2,161	25	1,761	727	172	70

	Number of power shovels and dragline excavators—Continued			Number of						
	By type of machine		Total	Carryall scrapers	Bull-dozers	Front-end loaders	Wheel excava-tors	Power brooms	Motor graders	Coal drills
	Power shovels	Dragline excava-tors								
Alabama	113	110	223	23	419	438	--	9	36	4
Alaska	--	--	--	--	7	5	--	--	2	1
Arizona	3	4	7	1	15	7	--	--	3	4
Arkansas	1	9	10	5	23	14	--	1	5	--
Colorado	6	10	16	29	46	25	--	--	13	10
Georgia	--	2	2	7	11	9	--	1	--	--
Illinois	56	57	113	51	246	66	9	3	36	24
Indiana	88	82	170	16	265	94	--	1	28	12
Iowa	3	9	12	8	12	9	--	--	2	7
Kansas	2	5	7	1	12	8	--	--	3	--
Kentucky:										
Eastern	66	6	72	76	876	703	2	40	182	17
Western	104	72	176	57	507	261	--	5	71	26
Total	170	78	248	133	1,383	964	2	45	253	43
Maryland	34	48	82	15	119	109	--	--	7	6
Missouri	14	16	30	7	65	33	--	--	11	1
Montana:										
Bituminous	6	6	12	26	31	14	--	--	9	8
Lignite	2	1	3	2	3	3	--	1	1	2
Total	8	7	15	28	34	17	--	1	10	10
New Mexico	2	5	7	15	24	12	--	--	9	4
North Dakota (lignite)	14	12	26	19	33	20	--	2	12	8
Ohio	186	142	328	297	860	468	8	21	113	11
Oklahoma	7	22	29	31	80	76	--	3	17	--
Pennsylvania	457	503	960	302	1,645	1,221	22	11	124	13
Tennessee	41	14	55	41	234	178	2	13	30	--
Texas (lignite)	8	8	16	5	18	5	--	--	8	--
Virginia	74	8	82	11	550	455	1	13	35	4
Washington	2	4	6	14	24	6	1	--	3	--
West Virginia	190	62	252	53	768	594	4	11	134	22
Wyoming	20	14	34	51	86	30	1	1	23	9
Total [1]	1,499	1,231	2,730	1,163	6,979	4,863	50	136	917	193

[1] Data may not add to totals shown because of independent rounding.

Table 27.—Number and production of bituminous coal and lignite strip-auger mines and units of strip-auger and loading equipment, in 1975, by State

State	Number of strip-auger mines	Production (thousand short tons)	Number of augers	Number of power shovels and dragline excavators: By type of power				By capacity of dipper or bucket, cubic yards			
				Electric	Diesel electric	Diesel	Gasoline	Less than 6	6–15	16–50	More than 50
Kentucky:											
Eastern	901	24,150	906	--	1	208	--	188	21	--	--
Western	9	331	10	--	--	6	1	5	2	--	--
Total	910	24,481	916	--	1	214	1	193	23	--	--
Ohio	23	5,912	20	8	3	8	--	3	8	6	2
Pennsylvania	3	48	3	--	--	3	--	3	--	--	--
Tennessee	1	17	1	--	--	--	--	--	--	--	--
Virginia	36	2,648	35	--	--	9	--	9	--	--	--
West Virginia	43	4,034	49	--	--	20	2	19	3	--	--
Total [1]	1,016	37,141	1,024	8	4	254	3	227	34	6	2

	Number of power shovels and dragline excavators—Continued			Number of units					
	By type of machine		Total						
	Power shovels	Dragline excavators		Carryall scrapers	Bull-dozers	Front-end loaders	Power brooms	Motor graders	Coal drills
Kentucky:									
Eastern	207	2	209	8	1,410	1,142	6	283	41
Western	1	6	7	1	17	12	--	4	1
Total	208	8	216	9	1,427	1,154	6	287	42
Ohio	10	9	19	19	82	33	3	13	1
Pennsylvania	--	3	3	--	6	3	--	--	--
Tennessee	--	--	--	--	2	2	--	1	--
Virginia	8	1	9	7	84	75	1	10	1
West Virginia	17	5	22	5	148	127	3	33	9
Total[1]	243	26	269	40	1,749	1,394	13	344	53

[1] Data may not add to totals shown because of independent rounding.

Table 28.—Equipment used at bituminous coal and lignite auger mines in the United States, in 1975

State	Number of auger mines	Production (thousand short tons)	Number of units: Augers	Power shovels	Bull-dozers	Front-end loaders	Power brooms	Motor graders
Alabama	1	11	1	--	1	--	--	--
Kentucky:								
Eastern	102	1,822	114	--	120	76	1	9
Western	--	--	--	--	--	--	--	--
Total	102	1,822	114	--	120	76	1	9
Maryland	6	36	7	--	4	5	--	--
Missouri	1	76	1	--	2	--	--	--
Ohio	25	495	25	1	36	13	--	1
Pennsylvania	39	354	39	1	38	12	--	1
Tennessee	9	152	9	--	8	7	--	--
Virginia	30	536	30	--	34	25	--	1
West Virginia	3	46	3	--	4	2	--	--
Total [1]	216	3,526	229	2	247	140	1	12

[1] Data may not add to totals shown because of independent rounding.

Table 29.—Number of power drills used at bituminous coal and lignite mines in the United States, in 1975, by State

State	Horizontal: Strip	Horizontal: Auger	Horizontal: Strip-auger	Vertical: Strip	Vertical: Auger	Vertical: Strip-auger	Total
Alabama	30	--	--	180	--	--	210
Alaska	--	--	--	--	--	--	--
Arizona	--	--	--	5	--	--	5
Arkansas	--	--	--	7	--	--	7
Colorado	3	--	--	10	--	--	13
Georgia	--	--	--	3	--	--	3
Illinois	21	--	--	35	--	--	56
Indiana	20	--	--	56	--	--	76
Iowa	2	--	--	1	--	--	3
Kansas	1	--	--	3	--	--	4
Kentucky:							
Eastern	62	6	198	297	16	456	1,035
Western	34	--	--	130	--	7	171
Total	96	6	198	427	16	463	1,206
Maryland	5	--	--	20	--	--	25
Missouri	10	--	--	16	--	--	26
Montana (bituminous)	1	--	--	8	--	--	9
New Mexico	--	--	--	7	--	--	7
North Dakota (lignite)	--	--	--	2	--	--	2
Ohio	45	--	--	126	--	14	185
Oklahoma	5	--	--	26	--	--	31
Pennsylvania	67	--	--	239	--	--	306
Tennessee	21	--	1	71	--	--	93
Texas (lignite)	1	--	--	1	--	--	2
Virginia	46	--	8	205	--	36	295
Washington	--	--	--	2	--	--	2
West Virginia	48	--	10	235	--	52	345
Wyoming	--	--	--	28	--	--	28
Total	422	6	217	1,713	16	565	2,939

Table 30.—Number of off-the-highway trucks in use at bituminous coal and lignite mines by capacity and method of dumping[1]

Capacity	End dump		Side dump		Bottom dump		All types	
	1974	1975	1974	1975	1974	1975	1974	1975
Under 20 tons	533	490	3	11	42	35	578	536
20 to 50 tons	1,125	1,428	3	1	223	205	1,351	1,634
51 to 100 tons	182	192	3	3	338	341	523	536
Over 100 tons	33	62	--	--	283	346	316	408
Total	1,873	2,172	9	15	886	927	2,768	3,114

[1] Numbers represent only those trucks reported to the Bureau of Mines.

Table 31.—Mechanical cleaning at bituminous coal and lignite mines, in 1975, by State

(Thousand short tons)

State	Total production	Mechanical cleaning			
		Number of cleaning plants	Raw coal	Cleaned coal	Refuse
Alabama	22,644	21	18,178	11,228	6,950
Colorado	8,219	3	2,386	2,043	342
Illinois	59,537	34	59,991	45,120	14,872
Indiana	25,124	11	24,986	19,402	5,585
Kentucky:					
Eastern	87,257	45	33,134	23,764	9,369
Western	56,357	17	25,751	19,814	5,938
Total[1]	143,613	62	58,885	43,578	15,307
Ohio	46,770	19	21,850	14,108	7,742
Pennsylvania	84,137	64	60,172	42,572	17,600
Utah	6,961	6	3,973	3,444	529
Virginia	35,510	23	19,267	12,875	6,393
West Virginia	109,283	124	91,398	63,139	28,259
Other States[2]	57,389	21	13,008	9,486	3,522
Total[1]	599,185	388	374,094	266,993	107,101
Other States[3]	49,253	--	--	--	--
Grand total[1]	648,438	388	374,094	266,993	107,101

[1] Data may not add to totals shown because of independent rounding.
[2] States cleaned include Alaska, Arkansas, Kansas, Maryland, Missouri, New Mexico, Oklahoma, Tennessee, Washington, and Wyoming.
[3] States not cleaned include Arizona, Georgia, Iowa, Montana (bituminous and lignite), North Dakota (lignite), and Texas.

Table 32.—Mechanical cleaning of bituminous coal and lignite, by type of equipment

(Thousand short tons)

Type of equipment	1974	1975
Wet methods:		
Jigs	129,302	124,317
Concentrating tables	28,869	28,682
Classifiers	2,698	6,176
Launders	3,577	2,664
Dense medium processes:		
Magnetite	68,749	72,448
Sand	12,427	13,533
Calcium chloride	1,107	951
Total[1]	82,283	86,931
Flotation	10,863	11,519
Total, wet methods	257,592	260,289
Pneumatic methods	7,557	6,704
Grand total[1]	265,150	266,993

[1] Data may not add to totals shown because of independent rounding.

Table 33.—Mechanical cleaning at bituminous coal and lignite mines, in 1975, by State and type of mine

(Thousand short tons)

State	Underground mines		Strip mines		Auger mines		Strip-auger mines		All mines[1]	
	Total production	Cleaned	Total production	Cleaned	Total production	Cleaned	Total production	Cleaned	Total production	Cleaned
Alabama	7,614	7,540	15,018	3,688	11	--	--	--	22,644	11,228
Colorado	3,446	2,029	4,773	15	--	--	--	--	8,219	2,043
Illinois	31,875	20,807	27,661	24,312	--	--	--	--	59,537	45,120
Indiana	188	--	24,935	19,402	--	--	--	--	25,124	19,402
Kentucky:										
Eastern	40,628	21,915	20,656	1,380	1,822	24	24,150	446	87,257	23,764
Western	25,004	5,974	31,022	13,840	--	--	331	--	56,357	19,814
Total[1]	65,632	27,889	51,678	15,220	1,822	24	24,481	446	143,613	43,578
Ohio	15,455	10,037	24,908	3,403	495	111	5,912	557	46,770	14,108
Pennsylvania	44,631	33,996	39,105	8,538	354	38	48	--	84,137	42,572
Utah	6,961	3,444	--	--	--	--	--	--	6,961	3,444
Virginia	23,181	12,395	9,145	225	536	--	2,648	254	35,510	12,875
West Virginia	88,357	58,628	16,846	3,779	46	--	4,034	731	109,283	63,139
Other States[2]	5,122	2,615	51,986	6,871	264	--	17	--	57,389	9,486
Total[1]	292,463	179,379	266,056	85,452	3,526	173	37,141	1,989	599,185	266,993
Other States[3]	363	--	48,890	--	--	--	--	--	49,253	--
Grand total[1]	292,826	179,379	314,945	85,452	3,526	173	37,141	1,989	648,438	266,993

[1] Data may not add to totals shown because of independent rounding.
[2] States cleaned include Alaska, Arkansas, Kansas, Maryland, Missouri, New Mexico, Oklahoma, Tennessee, Washington, and Wyoming.
[3] States not cleaned include Arizona, Georgia, Iowa, Montana (bituminous and lignite), North Dakota (lignite), and Texas.

Table 34.—Preparation other than mechanical cleaning of bituminous coal and lignite at mines, in 1975, by State

(Thousand short tons)

State	Crushed or screened	No processing
Alabama	8,966	2,450
Alaska	596	100
Arizona	6,986	--
Arkansas	230	47
Colorado	5,911	265
Georgia	57	17
Illinois	12,957	1,460
Indiana	5,425	297
Iowa	593	29
Kansas	--	8
Kentucky:		
Eastern	51,626	11,866
Western	25,404	11,139
Total	77,030	23,005
Maryland	1,923	546
Missouri	2,407	1,753
Montana	22,044	9
New Mexico	7,769	--
North Dakota (lignite)	6,437	2,078
Ohio	25,732	6,931
Oklahoma	2,139	132
Pennsylvania	29,595	11,971
Tennessee	5,253	1,311
Texas	10,734	268
Utah	3,498	19
Virginia	18,511	4,124
Washington	--	8
West Virginia	40,628	5,516
Wyoming	21,799	1,881
Total	317,220	64,225

Table 35.—Thermal drying of bituminous coal and lignite, by type of drying equipment

Type of dryer	Number of thermal drying units		Thermally dried (thousand short tons)	
	1974	1975	1974	1975
Fluidized-bed	56	58	24,616	25,866
Multilouver	12	12	3,006	1,969
Rotary	3	5	697	794
Screen	5	15	1,960	2,798
Suspension or flash	30	28	5,766	4,184
Vertical tray and cascade	--	1	--	70
Total	106	119	36,045	35,681

Table 36.—Comparison of thermal drying of bituminous coal and lignite with mechanical cleaning at mines, by State

State	Number of cleaning plants				Thousand short tons			
	Total		With thermal drying		Production mechanically cleaned		Thermally dried	
	1974	1975	1974	1975	1974	1975	1974	1975
Alabama	22	21	--	--	11,726	11,228	--	--
Colorado	3	3	1	1	1,775	2,043	1,098	1,580
Illinois	36	34	5	5	45,313	45,120	4,078	3,220
Indiana	11	11	--	--	19,097	19,402	--	--
Kentucky:								
Eastern	43	45	6	6	24,304	23,764	2,086	1,847
Western	19	17	1	1	19,324	19,814	246	372
Total	62	62	7	7	43,628	43,578	2,332	2,219
North Dakota (lignite)	--	--	1	2	--	--	13	74
Ohio	17	19	3	3	13,617	14,108	601	605
Pennsylvania	68	64	5	6	41,302	42,572	1,987	4,815
Tennessee	--	--	1	1	--	--	198	230
Texas	--	--	1	1	--	--	2,000	1,800
Utah	6	6	2	2	3,401	3,444	1,993	922
Virginia	19	23	7	9	13,872	12,875	5,006	4,101
West Virginia	126	124	35	39	62,833	63,139	16,738	16,117
Other States	17	21	--	--	8,584	9,486	--	--
Total [1]	387	388	68	76	265,150	266,993	36,045	35,681

[1] Data may not add to totals shown because of independent rounding.

Table 37.—Thermal drying of bituminous coal and lignite at mines, by State

State	Number of thermal drying units		Thousand short tons			
			Grand total production		Thermally dried	
	1974	1975	1974	1975	1974	1975
Colorado	1	1	6,896	8,219	1,098	1,580
Illinois	6	6	58,215	59,537	4,078	3,220
Kentucky:						
Eastern	6	6	85,356	87,257	2,086	1,847
Western	1	1	51,841	56,357	246	372
Total	7	7	137,197	143,613	2,332	2,219
North Dakota (lignite)	1	2	7,463	8,515	13	74
Ohio	6	6	45,409	46,770	601	605
Pennsylvania	6	9	80,462	84,137	1,987	4,815
Tennessee	1	1	7,541	8,206	198	230
Texas	9	9	7,684	11,002	2,000	1,800
Utah	3	5	5,858	6,961	1,993	922
Virginia	16	19	34,326	35,510	5,006	4,101
West Virginia	50	54	102,462	109,283	16,738	16,117
Other States	--	--	109,893	126,685	--	--
Total [1]	106	119	603,406	648,438	36,045	35,681

[1] Data may not add to totals shown because of independent rounding.

Table 38.—Bituminous coal and lignite loaded for shipment by railroads and waterways in the United States, in 1975, as reported by mine operators

(Thousand short tons)

Route	State	By State	Total for route
RAILROAD			
Alaska	Alaska	625	625
Atchison, Topeka & Santa Fe	New Mexico	1,482	1,542
	Oklahoma	60	
Baltimore & Ohio	Illinois	528	27,876
	Indiana	46	
	Maryland	145	
	Ohio	8,247	
	Pennsylvania	4,760	
	West Virginia	14,150	
Bevier & Southern	Missouri	623	623
Bessemer & Lake Erie	Pennsylvania	2,517	2,517
Black Mesa & Salt River	Arizona	2,818	2,818
Burlington Northern	Illinois	7,146	35,859
	Iowa	33	
	Missouri	102	
	Montana (bituminous and lignite)	21,766	
	North Dakota (lignite)	2,237	
	Wyoming	4,575	
Cambria & Indiana	Pennsylvania	3,461	3,461
Carbon County	Utah	667	667
Central of Georgia	Alabama	2	2
Chesapeake & Ohio	Kentucky	19,275	48,462
	Ohio	126	
	West Virginia	29,061	
Chicago & Illinois Midland	Illinois	885	885
Chicago, Milwaukee, St. Paul & Pacific	Indiana	3,136	4,958
	North Dakota (lignite)	1,822	
Chicago & North Western	Illinois	3,627	3,627
Chicago, Rock Island & Pacific	Illinois	1,046	1,148
	Missouri	102	
Clinchfield	Kentucky	205	4,205
	Virginia	4,000	
Colorado & Wyoming	Colorado	632	632
Denver & Rio Grande Western	Colorado	6,083	9,356
	Utah	3,274	
Erie-Lackawanna	Ohio	106	106
Illinois Central Gulf	Illinois	14,786	26,650
	Kentucky	11,865	
Illinois Terminal	Illinois	1	1
Kansas City Southern	Oklahoma	256	256
Kentucky & Tennessee	Kentucky	532	532
Lake Erie, Franklin & Clarion	Pennsylvania	455	455
Louisville & Nashville	Alabama	4,623	59,756
	Indiana	3,114	
	Kentucky	51,404	
	Tennessee	592	
	Virginia	23	
Mary Lee	Alabama	603	603
Missouri-Kansas-Texas	Missouri	603	823
	Oklahoma	220	
Missouri Pacific	Arkansas	213	15,556
	Illinois	15,024	
	Missouri	7	
	Oklahoma	311	
Monongahela	West Virginia	7,193	7,193
Montour	Pennsylvania	2,307	2,307
Norfolk & Western	Iowa	56	65,438
	Kentucky	15,635	
	Missouri	102	
	Ohio	4,145	
	Virginia	18,580	
	West Virginia	26,919	
Penn Central (includes coal shipped over Kanawha & Michigan, Kelley's Creek, Toledo & Ohio Central and Zanesville & Western)	Illinois	3,062	42,745
	Indiana	7,136	
	Ohio	9,173	
	Pennsylvania	19,532	
	West Virginia	3,841	
Pittsburgh & Shawmut	Pennsylvania	1,824	1,824

See footnotes at end of table.

Table 38.—Bituminous coal and lignite loaded for shipment by railroads and waterways in the United States, in 1975, as reported by mine operators—Continued

(Thousand short tons)

Route	State	By State	Total for route
RAILROAD—Continued			
St. Louis-San Francisco	Alabama	242	2,638
	Arkansas	194	
	Kansas	381	
	Missouri	235	
	Oklahoma	1,585	
Soo Line	North Dakota (lignite)	288	288
Southern	Alabama	4,411	18,352
	Georgia	57	
	Indiana	228	
	Kentucky	1,741	
	Tennessee	4,136	
	Virginia	7,779	
Squaw Creek	Indiana	449	449
Tennessee Coal, Iron & Railroad Co	Alabama	1,435	1,435
Union Pacific	Colorado	406	12,416
	Wyoming	12,010	
Utah	Utah	1,091	1,091
Western Maryland	Maryland	1,279	5,499
	Pennsylvania	1,299	
	West Virginia	2,922	
Woodward Iron Co	Alabama	754	754
Yankeetown	Indiana	1,720	1,720
Total railroad shipments[1]		418,148	418,148
WATERWAY			
Allegheny River	Pennsylvania	742	742
Arkansas River	Arkansas	3	165
	Oklahoma	162	
Black Warrior River	Alabama	1,750	1,750
Clarion River	Pennsylvania	44	44
Green River	Kentucky	12,860	12,860
Kanawha River	West Virginia	3,270	3,270
Mississippi River	Illinois	28	28
Monongahela River	Maryland	155	22,651
	Pennsylvania	15,367	
	West Virginia	7,128	
Ohio River	Illinois	2,191	25,787
	Indiana	4,240	
	Kentucky	9,169	
	Ohio	6,648	
	Pennsylvania	66	
	West Virginia	3,473	
Rough River	Kentucky	366	366
Tennessee River	Alabama	714	1,431
	Georgia	4	
	Tennessee	712	
Total waterway shipments[1]		69,094	69,094
Total loaded at mine for shipment by railroads and waterways[1]		487,243	487,243
Shipped by truck from mine to final destination		79,365	79,365
Coal transported to electric utility plants adjacent to or near the mine		73,543	73,543
All other[2]		8,288	8,288
Total production[1]		648,438	648,438

[1] Data may not add to totals shown because of independent rounding.
[2] Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, used for all other purposes at mine, and shipped by slurry pipeline.

Table 39.—Bituminous coal and lignite shipped by unit train in the United States

(Thousand short tons)

State	1974	1975
Alabama	3,276	2,413
Colorado	2,080	4,609
Illinois	24,262	21,200
Indiana	9,321	9,557
Kansas	164	205
Kentucky:		
Eastern	16,457	22,900
Western	8,101	2,527
Total	24,558	25,427
Maryland	559	341
Missouri	100	--
Montana (bituminous)	12,475	20,606
New Mexico	704	691
North Dakota (lignite)	1,687	3,185
Ohio	16,528	14,991
Oklahoma	921	568
Pennsylvania	16,888	19,950
Tennessee	1,134	1,107
Utah	2,233	3,325
Virginia	4,273	1,056
West Virginia	23,103	26,039
Wyoming	10,379	13,267
Total	154,645	[1] 168,536

[1] Data do not add to total shown because of independent rounding.

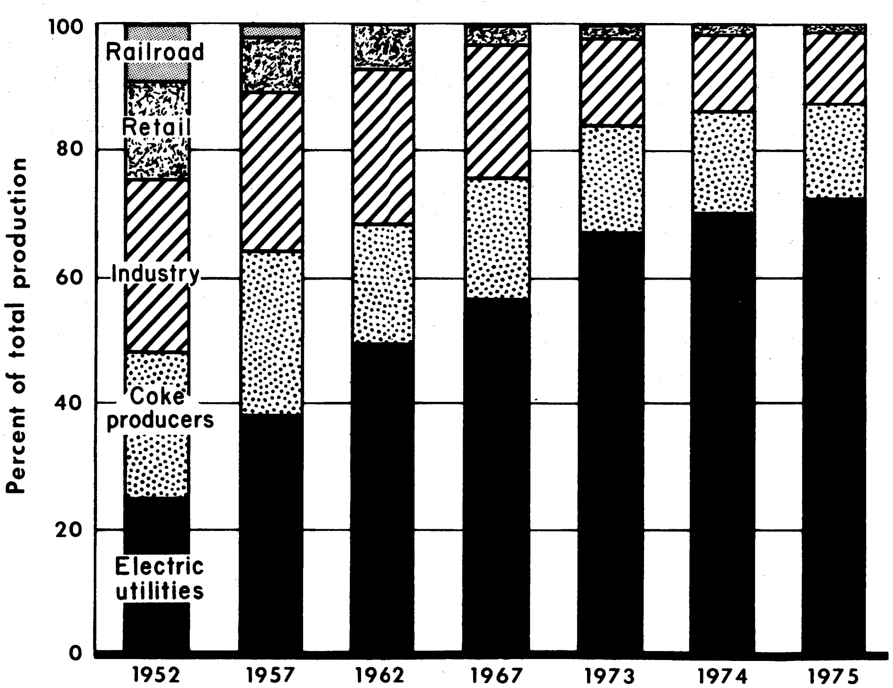

Figure 6.—Percentage of ·al consumption of bituminous coal and lignite, by consumer class and retail deliveries in the United States.

Table 40.—Consumption of bituminous coal and lignite, by consumer class, and retail deliveries in the United States

(Thousand short tons)

Year and month	Electric power utilities [1]	Bunker, lake vessel and foreign [2]	Manufacturing and mining industries				Retail deliveries to other consumers [5]	Total of classes shown [6]
			Beehive coke plants	Oven coke plants	Steel and rolling mills [3]	Other manufacturing and mining industries [4]		
1971	326,280	207	1,278	81,531	5,560	68,655	11,351	494,862
1972	348,612	163	1,059	86,213	4,850	67,131	8,748	516,776
1973	386,879	116	1,310	92,324	6,356	60,837	8,200	556,022
1974:								
January	34,399	--	107	7,870	530	5,830	1,310	50,046
February	30,377	--	102	7,205	605	5,540	1,100	44,929
March	31,460	3	107	7,553	635	5,260	840	45,858
April	29,690	10	111	7,659	725	4,880	520	43,595
May	31,539	8	108	7,796	660	4,420	420	44,951
June	31,582	6	106	7,576	525	4,130	390	44,315
July	35,968	7	99	7,671	460	4,020	380	48,605
August	35,430	9	128	7,588	420	4,464	540	48,579
September	30,756	9	132	7,402	440	4,345	760	43,844
October	31,904	8	139	7,572	425	5,010	810	45,868
November	32,002	15	99	6,482	380	4,800	820	44,598
December	34,961	5	99	6,036	350	5,120	950	47,521
Total	390,068	80	1,337	88,410	6,155	57,819	8,840	552,709
1975:								
January	35,710	1	112	7,191	416	5,290	1,121	49,841
February	31,983	1	108	6,923	359	5,662	663	45,699
March	32,690	--	108	7,772	302	5,678	652	47,202
April	30,147	3	100	7,327	254	5,340	366	43,537
May	30,128	4	89	7,193	210	4,776	258	42,658
June	33,120	3	81	6,919	147	4,201	306	44,777
July	36,186	2	91	6,547	114	4,070	444	47,454
August	37,759	2	94	6,470	137	4,322	406	49,190
September	32,361	2	97	6,190	135	4,666	581	44,032
October	32,717	3	94	6,565	171	4,689	690	44,929
November	33,199	2	89	6,396	227	5,308	725	45,946
December	37,249	1	62	6,654	243	5,757	1,070	51,036
Total	403,249	24	1,125	82,147	2,715	59,759	7,282	556,301

[1] Federal Power Commission.
[2] Bureau of Census, U.S. Department of Commerce, Ore and Coal Exchange.
[3] Estimates based upon reports collected from a selected list of representative steel and rolling mills.
[4] Estimates based upon reports collected from a selected list of representative manufacturing plants.
[5] Estimates based upon reports collected from a selected list of representative retailers. Includes some coal shipped by truck from mine to final destination.
[6] The total of classes shown approximates total consumption. The calculation of consumption from production, imports, exports, and changes in stocks is not as accurate as the "Total of classes shown" because certain significant items of stocks are not included in monthly stocks. These items are stocks on lake and tidewater docks, stocks at other intermediate storage piles between mine and consumer, and coal in transit.

Table 41.—Stocks and days' supply of bituminous coal and lignite in the United States, in 1975, by consumer class

(Thousand short tons)

Date	Electric power utilities [1]	Oven coke plants	Steel and rolling mills	Other manufacturing and mining industries	Retail dealers	Total
			STOCKS			
Jan. 31	81,181	7,140	339	6,639	213	95,512
Feb. 28	80,026	8,010	316	8,487	189	97,028
Mar. 31	80,904	8,665	269	7,832	152	97,822
Apr. 30	85,719	8,980	273	7,540	151	102,663
May 31	92,054	9,603	258	7,567	184	109,666
June 30	96,839	10,009	272	7,515	222	114,857
July 31	92,995	8,126	252	7,506	254	109,133
Aug. 31	93,051	7,340	224	7,640	267	108,522
Sept. 30	96,621	7,003	220	7,816	262	111,922
Oct. 31	104,227	7,729	232	7,900	256	120,344
Nov. 30	109,273	8,468	238	7,571	258	125,808
Dec. 31	109,707	8,671	254	8,250	233	127,115
			DAY'S SUPPLY [2]			
Jan. 31	70	31	25	39	6	59
Feb. 28	70	32	25	42	8	59
Mar. 31	77	35	28	43	7	64
Apr. 30	85	37	32	42	12	71
May 31	95	41	38	49	22	80
June 30	88	43	56	54	22	77
July 31	80	38	68	57	18	71
Aug. 31	76	35	51	55	20	68
Sept. 30	90	34	49	50	14	76
Oct. 31	99	36	42	52	12	83
Nov. 30	99	40	31	43	11	82
Dec. 31	91	40	33	44	7	77

[1] Federal Power Commission.

[2] Days' supply is calculated by dividing the total stocks at the end of the month by the daily average rate of consumption during the same month. By this method, seasonal variation in daily average rate of consumption is not reflected.

Table 42.—Distribution of bituminous coal and lignite, in 1975, by method of movement and consumer use

(Thousand short tons)

Shipments	Electric utilities	Coke and gas plants	Retail dealers	All others	Railroad fuel	Used at mines and sales to employees
Total shipments to all destinations in the United States, Canada, and Mexico, by all methods of movements and consumer use, and overseas exports	438,558	92,497	5,043	53,718	279	1,554
Shipments to all destinations in the United States, Canada, and Mexico by specific method of movement and consumer use:						
Method of movement:						
All-rail	235,576	51,726	2,837	30,001	--	--
River and ex-river	81,378	21,436	25	4,186	--	--
Great Lakes [1]	17,340	12,293	467	4,146	--	--
Tidewater [2]	1,693	3,617	--	43	--	--
Truck	51,056	3,367	1,714	13,542	--	--
Tramway, conveyor, and private railroad	51,515	58	--	1,800	--	--
Method of movement and/or consumer uses unknown	--	--	--	--	279	1,554
Total	438,558	92,497	5,043	53,718	279	1,554

Shipments	Canadian Great Lakes commercial docks [3]	U.S. Great Lakes dock storage [3]	U.S. tidewater dock storage [3]	Overseas exports [4]	Net change in mine inventory	Total
Total shipments to all destinations in the United States, Canada, and Mexico, by all methods of movements and consumer use, and overseas exports	164	134	--	48,405	474	640,826
Shipments to all destinations in the United States, Canada, and Mexico by specific method of movement and consumer use:						
Method of movement:						
All-rail	--	--	--	--	--	320,140
River and ex-river	--	--	--	--	--	107,025
Great Lakes [3]	--	--	--	--	--	34,246
Tidewater [4]	--	--	--	--	--	5,353
Truck	--	--	--	--	--	69,679
Tramway, conveyor, and private railroad	--	--	--	--	--	53,373
Method of movement and/or consumer uses unknown	164	134	--	48,405	474	51,010
Total	164	134	--	48,405	474	640,826

[1] Excludes shipments to Canadian Great Lakes commercial docks and U.S. dock storage for which consumer uses are not available; however, includes vessel fuel, the destinations of which are not available.
[2] Excludes overseas exports for which consumer uses are not available.
[3] Consumer use unknown.
[4] Excludes Canada; consumer use unknown.

Table 43.—Distribution of bituminous coal and lignite, in 1975, by district of origin and consumer use

(Thousand short tons)

District of origin [1]	Electric utilities	Coke and gas plants	Retail dealers	All others	Rail-road fuel	Used at mines and sales to employees	Canadian Great Lakes com-mercial docks [2]	U.S. Great Lakes dock storage [2]	Overseas exports [3]	Net change in mine inven-tory
1	36,587	6,657	63	3,749	96	143	28	--	4,890	462
2	12,813	19,620	128	2,818	1	18	3	--	17	—360
3 and 6	34,809	2,433	109	2,346	14	7	36	--	2,677	—10
4	40,327	--	735	5,307	5	31	--	--	--	—255
7	869	12,660	127	902	36	1,028	75	--	13,528	—385
8	79,625	34,643	2,320	17,984	117	80	22	134	24,512	72
9	53,540	--	33	2,110	1	--	--	--	--	—20
10	49,284	4,269	330	6,004	1	47	--	--	--	94
11	21,657	40	416	2,931	--	1	--	--	--	66
12	620	--	1	23	--	--	--	--	--	--
13	13,255	5,846	18	1,742	--	--	--	--	2,558	155
14	46	533	--	238	--	--	--	--	176	14
15	16,728	338	42	2,337	--	--	--	--	--	85
16	179	--	--	255	--	--	--	--	--	23
17	4,394	3,741	13	421	--	13	--	--	11	20
18	14,928	--	--	153	--	--	--	--	--	225
19	22,200	58	170	1,360	--	4	--	--	--	2
20	3,476	1,654	243	1,421	4	25	--	--	36	180
21	7,521	--	88	806	--	157	--	--	--	—2
22 and 23	25,700	5	207	811	4	--	--	--	--	108
Total	438,558	92,497	5,043	53,718	279	1,554	164	134	48,405	474

[1] Producing districts are defined in: Bureau of Mines Bituminous Coal and Lignite Distribution Calendar Year 1975, Mineral Industry Survey, Apr. 12, 1976, 51 pp.
[2] Consumer use unknown.
[3] Excludes Canada; consumer use unknown.

Table 44.—Distribution of bituminous coal and lignite, in 1975, by destination and consumer use

(Thousand short tons)

Destination	Total	Electric utilities	Coke and gas plants	Retail dealers	All other [1]
New England:					
Massachusetts	390	288	--	11	91
Connecticut	24	--	--	--	24
Maine	29	--	--	4	25
New Hampshire	1,058	1,054	--	--	4
Vermont	10	8	--	--	2
Rhode Island	1	--	--	--	1
Total	1,512	1,350	--	15	147
Middle Atlantic:					
New York	11,844	6,155	3,491	77	2,121
New Jersey	2,368	2,329	--	1	38
Pennsylvania	63,390	35,778	22,796	218	4,598
Total	77,602	44,262	26,287	296	6,757
East North Central:					
Ohio	68,019	46,412	12,528	744	8,335
Indiana	46,928	28,715	14,072	596	3,545
Illinois	41,948	34,853	3,094	507	3,494
Michigan	31,290	21,802	5,343	262	3,883
Wisconsin	14,075	11,598	253	382	1,842
Total	202,260	143,380	35,290	2,491	21,099
West North Central:					
Minnesota	11,033	8,782	957	154	1,140
Iowa	6,741	5,560	--	92	1,089
Missouri	19,741	17,858	278	103	1,502
North Dakota	5,650	5,069	--	101	480
South Dakota	2,200	2,134	--	16	50
Nebraska	1,733	1,468	--	6	259
Kansas	3,333	3,220	--	--	113
Total	50,431	44,091	1,235	472	4,633
South Atlantic:					
Delaware	994	972	--	--	22
Maryland	7,861	3,979	3,574	14	294
District of Columbia	368	112	--	10	246
Virginia	6,561	3,987	--	212	2,362
West Virginia	34,360	26,336	4,481	158	3,385
North Carolina	21,315	19,825	--	245	1,245
South Carolina	5,651	4,497	--	160	994
Georgia	15,018	14,619	--	34	365
Florida	5,469	5,451	--	--	18
Total	97,597	79,778	8,055	833	8,931
East South Central:					
Kentucky	28,480	25,724	1,241	187	1,328
Tennessee	26,633	24,659	170	215	1,589
Alabama	28,205	19,246	6,783	13	2,163
Mississippi	1,593	1,573	--	--	20
Total	84,911	71,202	8,194	415	5,100
West South Central:					
Arkansas	34	--	--	--	34
Oklahoma	19	--	--	2	17
Texas	12,370	9,070	975	--	2,325
Total	12,423	9,070	975	2	2,376
Mountain:					
Colorado	8,210	6,431	1,085	14	680
Utah	4,514	1,996	1,971	87	460
Montana	1,252	1,203	--	7	42
Idaho	511	--	--	125	386
Wyoming	7,855	7,283	--	33	539
New Mexico	7,422	7,422	--	--	--
Arizona	3,985	3,873	--	--	112
Nevada	4,512	4,444	--	5	63
Total	38,261	32,652	3,056	271	2,282
Pacific:					
Washington	4,121	3,718	--	13	390
Oregon	107	--	--	9	98
California	2,136	--	1,861	--	275
Total	6,364	3,718	1,861	22	763

See footnotes at end of table.

Table 44.—Distribution of bituminous coal and lignite, in 1975, by destination and consumer use—Continued

(Thousand short tons)

Destination	Total	Electric utilities	Coke and gas plants	Retail dealers	All other [1]
Alaska	768	257	--	11	500
Canada [2]	16,570	8,696	7,002	199	673
Mexico	527	--	454	--	73
Destinations not revealable	307	102	88	16	101
Destinations and/or consumer uses not available:					
Great Lakes movement:					
Canadian commercial docks	164	--	--	--	--
Vessel fuel	283	--	--	--	--
U.S. dock storage	134	--	--	--	--
Tidewater movement:					
Overseas exports (except Canada)	48,405	--	--	--	--
Bunker fuel	--	--	--	--	--
U.S. dock storage	--	--	--	--	--
Railroad fuel:					
U.S. companies	278	--	--	--	--
Canadian companies	1	--	--	--	--
Coal used at mines and sales to employees	1,554	--	--	--	--
Net change in mine inventory	474	--	--	--	--
Grand total	640,826	--	--	--	--

[1] Excludes vessel fuel and bunker fuel, the destinations of which are not available.
[2] Excludes shipments to Canadian Great Lakes commercial docks and Canadian railroad companies.

Table 45.—Total bituminous coal and lignite shipments and percent of grand total shipments, by geographic division and State of destination

Geographic division and State of destination	Thousand short tons					Percent of total				
	1971	1972	1973	1974	1975	1971	1972	1973	1974	1975
New England:										
Massachusetts	227	147	106	749	390	(1)	(1)	(1)	0.1	0.1
Connecticut	1,271	109	118	214	24	0.2	(1)	(1)	(1)	(1)
Maine, New Hampshire, Vermont, Rhode Island	947	1,266	1,109	1,092	1,098	.2	0.2	0.2	.2	.2
Total	2,445	1,522	1,333	2,055	1,512	.4	.2	.2	.3	.3
Middle Atlantic:										
New York	15,596	13,177	13,290	14,742	11,844	2.8	2.2	2.3	2.4	1.8
New Jersey	2,974	1,303	2,524	3,058	2,368	.5	.2	.4	.5	.4
Pennsylvania	58,982	64,518	64,469	63,322	63,390	10.7	10.8	10.9	10.5	9.9
Total	77,552	78,998	80,283	81,122	77,602	14.0	13.2	13.6	13.4	12.1
East North Central:										
Ohio	63,116	67,795	65,557	69,642	68,019	11.4	11.4	11.1	11.5	10.6
Indiana	38,599	46,618	45,061	43,921	46,928	7.0	7.8	7.6	7.3	7.3
Illinois	38,289	42,028	40,628	39,054	41,948	6.9	7.1	6.9	6.5	6.6
Michigan	32,625	35,085	31,685	29,250	31,290	5.9	5.9	5.4	4.9	4.9
Wisconsin	15,340	14,978	12,634	12,335	14,075	2.8	2.5	2.2	2.0	2.2
Total	187,969	206,504	195,565	194,202	202,260	34.0	34.7	33.2	32.2	31.6
West North Central:										
Minnesota	8,313	8,639	9,161	9,668	11,033	1.5	1.4	1.6	1.6	1.7
Iowa	6,239	6,956	6,889	6,589	6,741	1.1	1.2	1.2	1.1	1.1
Missouri	13,358	15,810	17,385	17,844	19,741	2.4	2.7	2.9	3.0	3.1
North Dakota and South Dakota	5,272	5,834	5,816	6,254	7,850	1.0	1.0	1.0	1.0	1.2
Nebraska and Kansas	2,225	2,348	3,527	3,611	5,066	.4	.4	.6	.6	.8
Total	35,407	39,587	42,778	43,966	50,431	6.4	6.7	7.3	7.3	7.9
South Atlantic:										
Delaware and Maryland	11,599	9,744	10,596	9,691	8,855	2.1	1.6	1.8	1.6	1.4
District of Columbia	598	458	548	496	368	.1	.1	.1	.1	(1)
Virginia	9,258	8,027	7,910	7,410	6,561	1.7	1.3	1.3	1.2	1.0
West Virginia	26,606	32,459	32,305	33,784	34,360	4.8	5.5	5.5	5.6	5.4
North Carolina	19,779	21,489	19,820	21,337	21,315	3.6	3.6	3.3	3.5	3.3
South Carolina	6,219	6,915	6,999	8,061	5,651	1.1	1.2	1.2	1.4	.9
Georgia and Florida	16,295	17,815	16,894	17,025	20,487	2.9	3.0	2.9	2.8	3.2
Total	90,354	96,907	95,072	97,804	97,597	16.3	16.3	16.1	16.2	15.2
East South Central:										
Kentucky	25,590	27,389	25,078	25,445	28,480	4.6	4.6	4.2	4.2	4.4
Tennessee	18,907	21,390	22,238	18,916	26,633	3.4	3.6	3.8	3.2	4.2
Alabama and Mississippi	27,694	30,064	27,695	26,719	29,798	5.0	5.0	4.7	4.4	4.7
Total	72,191	78,843	75,011	71,080	84,911	13.0	13.2	12.7	11.8	13.3

West South Central:										
Arkansas, Louisiana, Oklahoma, Texas	887	930	8,049	8,894	12,423	.2	.2	1.4	1.5	1.9
Mountain:										
Colorado	4,475	5,516	6,490	7,290	8,210	.8	.9	1.1	1.2	1.3
Utah	2,993	3,017	3,957	4,252	4,514	.5	.5	.7	.7	.7
Montana and Idaho	1,348	1,281	1,395	r 1,379	1,763	.3	.2	.2	.2	.3
Wyoming	3,728	5,152	6,200	6,731	7,855	.7	.9	1.1	1.1	1.2
New Mexico	6,713	6,851	7,343	7,686	7,422	1.2	1.1	1.2	1.3	1.2
Arizona and Nevada	2,324	4,513	4,451	7,634	8,497	.4	.8	.8	1.3	1.3
Total	21,581	26,330	29,836	34,972	38,261	3.9	4.4	5.1	5.8	6.0
Pacific:										
Washington and Oregon	1,482	2,865	3,510	4,316	4,228	.3	.5	.6	.7	.7
California	1,847	1,780	2,398	2,184	2,136	.3	.3	.4	.4	.3
Total	3,329	4,645	5,908	6,500	6,364	.6	.8	1.0	1.1	1.0
Alaska	748	707	707	690	768	.1	.1	.1	.1	.1
Canada [2]	17,522	18,162	16,231	13,706	16,735	3.2	3.1	2.7	2.3	2.6
Mexico	291	466	305	411	527	.1	.1	.1	.1	.1
Destinations not revealable	[3] 2,179	[4] 1,702	[5] 1,755	408	307	[3] .4	[4] .3	[5] .3	.1	(1)
U.S. railroad fuel	528	357	224	256	278	.1	.1	(2)	(1)	(1)
U.S. Great Lakes dock storage	—263	—266	—117	228	134	(2)	(2)	(2)	(1)	(1)
Vessel fuel	713	595	600	571	283	.1	.1	.1	.1	(1)
Overseas exports	[6] 37,810	[7] 36,607	[8] 35,570	45,809	48,405	[6] 6.8	[7] 6.1	[8] 6.0	7.6	7.6
Coal used at mines and sales to employees	1,483	1,521	1,600	1,701	1,554	.3	.2	.3	.2	.2
Change in mine inventory	397	1,097	—922	—896	474	.1	.2	—.2	—.1	.1
Grand total	553,123	595,214	589,788	603,479	640,826	100.0	100.0	100.0	100.0	100.0

r Revised.
[1] Less than 0.1%.
[2] Included shipments to Canadian Great Lakes commercial docks and railroad companies.
[3] Includes overseas exports from producing districts 13, 14, 17, and 20.
[4] Includes overseas exports from producing districts 13, 14, and 20.
[5] Includes overseas exports from producing districts 13 and 14.
[6] Excludes overseas exports from producing districts 13, 14, 17 and 20.
[7] Excludes overseas exports from producing districts 13, 14, and 20.
[8] Excludes overseas exports from producing districts 13 and 14.

Table 46.—Shipments of bituminous coal and lignite by consumer use and average sulfur content, in 1975

District	Quantity shipped (thousand short tons)						Average sulfur content (percent)					
	Electric utilities	Coke and gas plants	Other industrial uses and retail dealers	All other uses	Exports (overseas)	Total [1]	Electric utilities	Coke and gas plants	Other industrial uses and retail dealers	All other uses	Exports (overseas and Canada)	Total
1. Eastern Pennsylvania	37,244	7,000	3,827	2,746	4,208	55,024	2.1	1.0	2.0	2.1	1.6	1.9
2. Western Pennsylvania	9,931	15,548	4,743	3,161	851	34,233	2.2	1.5	1.7	2.0	2.3	1.7
3. Northern West Virginia	24,012	2,317	2,559	682	5,563	35,133	2.6	1.3	2.2	1.9	2.1	2.4
4. Ohio	41,437	--	4,812	521	--	46,770	3.5	--	3.2	3.0	--	3.4
5. Michigan	--	--	--	--	--	--	--	--	--	--	--	--
6. Panhandle	6,931	--	308	179	--	7,418	4.1	--	3.4	3.2	--	4.0
7. Southern Number 1	136	12,167	4,072	1,108	9,574	27,057	.7	.7	.6	.7	.8	.7
8. Southern Number 2	88,910	39,730	13,882	4,396	19,879	166,795	1.2	.9	.9	1.2	.8	1.0
9. West Kentucky	53,489	--	2,598	269	--	56,357	3.8	--	3.1	2.3	--	3.7
10. Illinois	47,415	2,874	8,729	287	232	59,537	3.3	1.0	2.7	2.4	1.1	3.1
11. Indiana	21,242	--	3,832	50	--	25,124	3.4	--	3.6	4.0	--	3.5
12. Iowa	618	--	1	3	--	622	3.9	--	3.0	3.1	--	3.7
13. Southeastern	13,175	5,944	1,781	927	2,229	24,056	1.4	1.0	1.9	.6	1.1	1.3
14. Arkansas-Oklahoma	12	568	214	15	243	1,053	1.0	1.1	2.0	.9	1.3	1.3
15. Southwestern	16,771	212	2,410	34	(2)	19,428	2.6	.8	1.7	1.8	--	2.4
16. Northern Colorado	215	--	244	25	--	483	.4	--	.4	.3	--	.4
17. Southern Colorado	4,491	3,579	402	82	198	8,751	.6	.6	.7	.7	.5	.6
18. New Mexico	14,755	--	1	--	--	14,755	.7	--	.5	--	--	.7
19. Wyoming	20,973	106	2,459	266	--	23,804	.6	.8	.7	.7	--	.6
20. Utah	3,523	1,458	1,428	484	68	6,961	.5	.9	.6	.6	.6	.6
21. North Dakota	7,615	--	691	208	--	8,515	.7	--	.6	1.5	--	.7
22. Montana	21,226	--	827	(2)	--	22,054	.7	--	1.2	--	--	.8
23. Washington	4,451	--	51	8	--	4,509	.5	--	.3	.5	--	.5
Total [1]	438,571	91,502	59,871	15,451	43,044	648,438	2.3	1.0	1.8	1.6	1.1	1.9

[1] Data may not add to totals shown because of independent rounding.
[2] Less than 1,000 short tons.

Table 47.—Exports of bituminous coal, by country group

(Thousand short tons and thousand dollars)

Country group	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Canada (including Newfoundland) and Mexico	16,536	253,011	14,117	356,384	17,262	676,773
Overseas (all other countries):						
West Indies and Central America	(1)	1	(1)	13	(1)	10
Bermuda, Greenland, Miquelon, St. Pierre Islands	2	32	--	--	--	--
South America	2,654	54,154	2,350	97,285	3,274	191,550
Europe	14,253	290,327	15,856	633,601	18,972	909,755
Asia	19,381	403,954	27,603	1,333,050	25,943	1,444,077
Africa	(1)	5	(1)	(1)	218	10,728
Oceania	44	973	(1)	1	--	--
Total	36,334	749,446	45,809	2,063,950	48,407	2,556,120
Grand total	52,870	1,002,457	59,926	2,420,334	65,669	3,232,893

[1] Less than ½ unit.

Table 48.—Bituminous coal exported from the United States, by country [1]

(Thousand short tons and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	44	973	(2)	(2)	--	--
Argentina	772	15,400	630	28,796	930	55,833
Belgium-Luxembourg	1,205	25,461	1,109	48,259	627	33,986
Brazil	1,645	33,482	1,292	53,580	2,007	115,651
Canada	16,231	246,247	13,706	343,398	16,735	650,018
Chile	194	4,481	312	11,532	289	17,944
Egypt	--	--	--	--	218	10,728
France	1,866	39,882	2,510	106,990	3,583	159,983
Germany, West	1,633	30,589	1,484	60,137	1,989	90,118
Greece	33	646	41	950	119	4,400
Israel	--	--	11	422	(2)	2
Italy	3,294	64,543	3,903	151,446	4,493	212,418
Japan	19,190	399,573	27,346	1,320,155	25,423	1,412,751
Korea, Republic of	191	4,377	246	12,464	319	21,048
Mexico	305	6,764	411	12,986	527	26,755
Netherlands	1,780	36,111	2,545	95,355	2,093	103,693
Norway	126	2,757	145	6,904	81	4,987
Peru	22	380	85	2,236	48	2,115
Portugal	395	8,267	334	14,347	246	14,391
Romania	284	5,879	163	5,528	343	17,521
Spain	2,234	47,252	2,017	87,768	2,691	149,279
Sweden	342	6,815	200	6,181	764	40,772
Switzerland	--	--	--	--	33	949
Turkey	--	--	--	--	201	10,263
United Kingdom	941	19,932	1,405	49,736	1,889	76,267
Uruguay	21	406	31	1,137	--	--
Yugoslavia	120	2,193	--	--	21	958
Other	2	47	(2)	27	(2)	63
Total	52,870	1,002,457	59,926	2,420,334	65,669	3,232,893

[1] Amounts stated do not include fuel or bunker coal on vessels engaged in foreign trade, which aggregated 11,898 tons ($231,789) in 1973, [r] 3,353 tons ($70,799) in 1974, and 200 tons ($3,777) in 1975.

[2] Less than ½ unit.

Table 49.—Bituminous coal exported from the United States, by customs district

(Thousand short tons and thousand dollars)

Customs district	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Baltimore	4,402	85,646	5,949	255,528	6,768	378,850
Buffalo	13	226	36	923	70	3,753
Charleston	--	--	(1)	(1)	--	--
Chicago	81	974	38	582	42	1,299
Cleveland	15,933	240,980	13,240	327,064	16,309	628,275
Detroit	106	1,888	136	4,660	122	6,031
Duluth	7	119	(1)	25	(1)	10
El Paso	22	401	24	500	50	1,413
Houston	--	--	(1)	3	--	--
Laredo	282	6,354	386	12,461	455	24,056
Los Angeles	(1)	3	115	4,174	(1)	9
Mobile	1,123	19,277	1,746	52,578	2,745	153,275
New Orleans	653	11,734	992	27,341	1,292	55,888
New York City	1	6	1	20	(1)	16
Nogales	(1)	9	--	--	(1)	4
Norfolk	30,192	633,815	35,745	1,648,712	36,953	1,929,963
Ogdensburg	23	460	24	650	25	1,175
Pembina	8	157	18	701	4	220
Philadelphia	22	377	1,431	83,461	803	47,423
Port Arthur	--	--	27	564	29	1,097
Portland, Maine	--	--	4	73	--	--
Portland, Oreg	(1)	1	13	253	--	--
San Diego	(1)	1	1	25	(1)	3
San Francisco	(1)	3	(1)	6	(1)	11
San Juan	(1)	1	(1)	5	(1)	4
Seattle	2	25	(1)	25	2	118
Total	52,870	1,002,457	59,926	2,420,334	65,669	3,232,893

[1] Less than ½ unit.

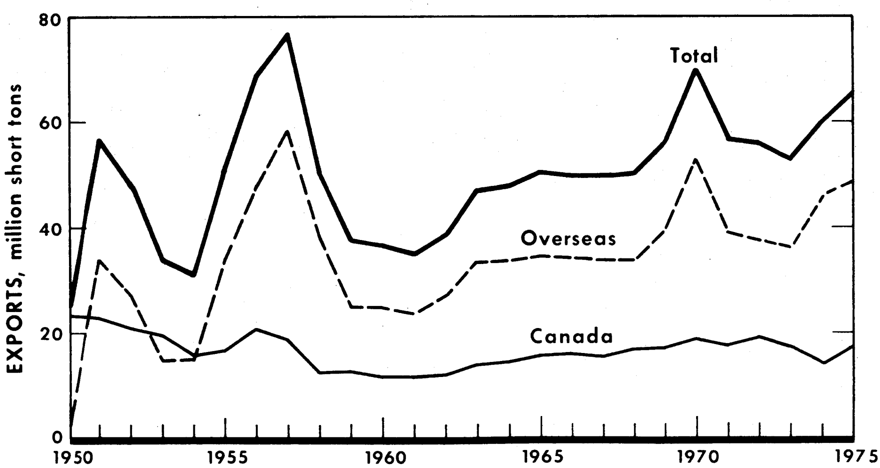

Figure 7.—Exports of bituminous coal and lignite from the United States to Canada and overseas.

Table 50.—Bituminous coal [1] imported for consumption into the United States, by country and customs district

Country and customs district	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Country:						
Australia	--	--	143,633	$2,566	117,294	$2,109
Belgium-Luxembourg	--	--	1,135	60	--	--
Brazil	--	--	18	(2)	--	--
Canada	113,884	$1,491	595,587	11,305	190,052	5,976
France	--	--	764	94	1,821	300
Germany, West	59	1	513,219	24,432	88,369	5,073
Japan	--	--	--	--	12	1
Netherlands	--	--	171,185	7,817	--	--
Norway	--	--	1,654	139	--	--
Panama	--	--	1,128	15	--	--
Poland	12,698	115	468,344	7,040	171,703	2,581
South Africa, Republic of	--	--	172,223	3,236	370,455	5,641
United Kingdom	--	--	11,517	1,027	--	--
Yugoslavia	--	--	--	--	15	1
Total	126,641	1,607	2,080,407	57,731	939,721	21,682
Customs district:						
Baltimore	--	--	622,824	17,659	115,820	5,858
Boston	12,698	115	666,954	11,000	319,624	5,140
Buffalo	437	8	1,005	47	20,532	707
Chicago	403	6	151	3	--	--
Cleveland	--	--	1,381	62	37,138	548
Detroit	73,152	897	101,866	1,597	2,307	35
Duluth	25,076	377	41,705	823	5,935	160
Great Falls	2,143	13	10,983	340	7,061	156
Los Angeles	--	--	--	--	112	11
Mobile	--	--	117,246	1,842	370,581	6,313
New Orleans	--	--	13,189	1,166	--	--
New York City	--	--	--	--	70	6
Norfolk	12,521	188	--	--	--	--
Ogdensburg	144	2	--	--	792	11
Pembina	59	1	29,380	634	15,617	248
Philadelphia	--	--	470,521	22,495	33,882	2,389
Portland, Maine	8	(2)	3,202	63	1,619	33
Providence	--	--	--	--	8,560	65
Seattle	--	--	--	--	71	2
Total	126,641	1,607	2,080,407	57,731	939,721	21,682

[1] Includes slack, culm, and lignite.
[2] Less than ½ unit.

Table 51.—Bituminous coal and lignite coal: World production, by country

(Thousand short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Canada:			
Bituminous	r 18,539	19,148	23,250
Lignite	4,028	3,842	3,750
Mexico: Bituminous	4,699	5,694	5,725
United States:			
Bituminous	577,574	585,504	628,619
Lignite	14,164	15,496	19,819
South America:			
Argentina: Bituminous	499	690	554
Brazil: Bituminous (marketable)	r 2,112	2,677	e 2,600
Chile: Bituminous (marketable)	1,426	1,554	1,500
Colombia: Bituminous [e]	3,600	3,900	4,300
Peru: Bituminous	106	e r 110	e 110
Venezuela: Bituminous	55	63	66
Europe:			
Albania: Lignite [2]	894	e 987	e 1,100
Austria: Lignite [3]	4,006	4,001	3,745
Belgium: Bituminous	6,988	6,694	6,583
Bulgaria:			
Bituminous [4]	246	209	e 240
Lignite [2]	29,166	26,453	30,291
Czechoslovakia:			
Bituminous [4]	30,625	30,767	30,993
Lignite [2]	89,562	90,561	94,393
France:			
Bituminous	20,492	18,650	19,142
Lignite	3,047	3,041	3,512
Germany, East:			
Bituminous	830	655	595
Lignite [2]	271,438	268,368	271,843
Germany, West:			
Bituminous [4]	99,843	96,443	93,994
Lignite [2]	130,798	138,940	136,000
Greece: Lignite	14,460	15,356	19,736
Hungary:			
Bituminous	3,165	3,537	3,333
Lignite [2]	25,762	24,860	24,101
Italy:			
Bituminous	(5)	4	--
Lignite	r 1,323	1,301	e 1,370
Poland:			
Bituminous	172,655	178,579	189,183
Lignite [2]	43,227	43,899	43,942
Romania:			
Bituminous [4]	r 8,575	8,529	e 8,500
Lignite [2]	r 18,802	21,099	e 23,100
Spain:			
Bituminous	7,690	8,065	8,256
Lignite	3,306	3,197	3,726
Svalbard (Spitzbergen): Bituminous [6]	457	481	429
U.S.S.R.: [7]			
Bituminous	478,610	493,322	506,000
Lignite [2]	173,019	177,076	183,000
United Kingdom: Bituminous	r 139,797	117,599	e 139,000
Yugoslavia:			
Bituminous	635	665	661
Lignite [2]	35,135	36,369	38,506
Africa:			
Algeria: Bituminous [8]	14	--	--
Mozambique: Bituminous	434	470	e 630
Nigeria: Bituminous	360	306	346
Rhodesia, Southern: Bituminous [9]	r 3,494	3,532	e 3,570
South Africa, Republic of:			
Bituminous (marketable)	67,179	71,232	74,791
Swaziland: Bituminous	154	128	140
Tanzania: Bituminous	2	2	1
Zaire: Bituminous	127	105	98
Zambia: Bituminous	1,036	892	e 800
Asia:			
Afghanistan: Bituminous [10]	126	169	176
Burma: Bituminous	15	19	28
China, People's Republic of:			
Bituminous and lignite [e]	450,000	r 475,000	500,000
India:			
Bituminous	r 85,837	92,706	105,000
Lignite	r 3,660	3,355	3,111
Indonesia: Bituminous	164	172	228
Iran: Bituminous	1,157	1,323	1,102

See footnotes at end of table.

Table 51.—Bituminous coal and lignite coal: World production, by country—Continued

(Thousand short tons)

Country [1]	1973	1974	1975 p
Asia—Continued			
Japan:			
Bituminous	r 24,707	22,414	20,841
Lignite	94	83	--
Korea, North: Bituminous e [11]	7,700	8,700	8,800
Mongolia:			
Bituminous	130	151	e 180
Lignite	2,432	2,576	e 2,800
Pakistan: Bituminous and lignite [12]	1,280	1,653	1,100
Philippines: Bituminous	43	56	111
Taiwan: Bituminous	r 3,668	3,235	3,462
Thailand: Lignite	398	534	510
Turkey: [13]			
Bituminous	r 5,126	5,492	e 5,800
Lignite	r 7,193	7,911	e 8,700
Oceania:			
Australia:			
Bituminous	r 66,857	69,640	73,958
Lignite	27,201	30,031	31,060
New Zealand:			
Bituminous	2,562	2,669	2,509
Lignite	160	159	150
World total:			
Bituminous	1,850,110	1,866,952	1,976,204
Lignite	903,275	919,495	948,265
Mixed grades [14]	451,280	476,653	501,100
Total, all grades	r 3,204,665	3,263,100	3,425,569

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Ecuador produces coal, but output was less than 500 tons annually in the years covered by this table.

[2] Includes material reported in national sources as brown coal.

[3] Available sources report only lignite production; a small amount of bituminous coal may also be produced.

[4] Official sources report the aggregate of bituminous coal and anthracite; distribution to these separate grades is estimated from reported total.

[5] Revised to zero.

[6] Output from Norwegian controlled portion only. Output of that portion of Svalbard controlled by the U.S.S.R. is presumably included in the total output recorded for that country. The U.S.S.R. output in short tons was as follows: 1973, 536,000; 1974, 540,000; 1975, 440,000.

[7] Run-of-mine output.

[8] May include a small amount of anthracite.

[9] Sales for year ending August 31 of that stated.

[10] Year beginning March 21 of that stated.

[11] Data include low-ranked coals, including some lignite.

[12] Year ending June 30 of that stated.

[13] Includes private sales.

[14] Bituminous coal plus lignite for the People's Republic of China and Pakistan.

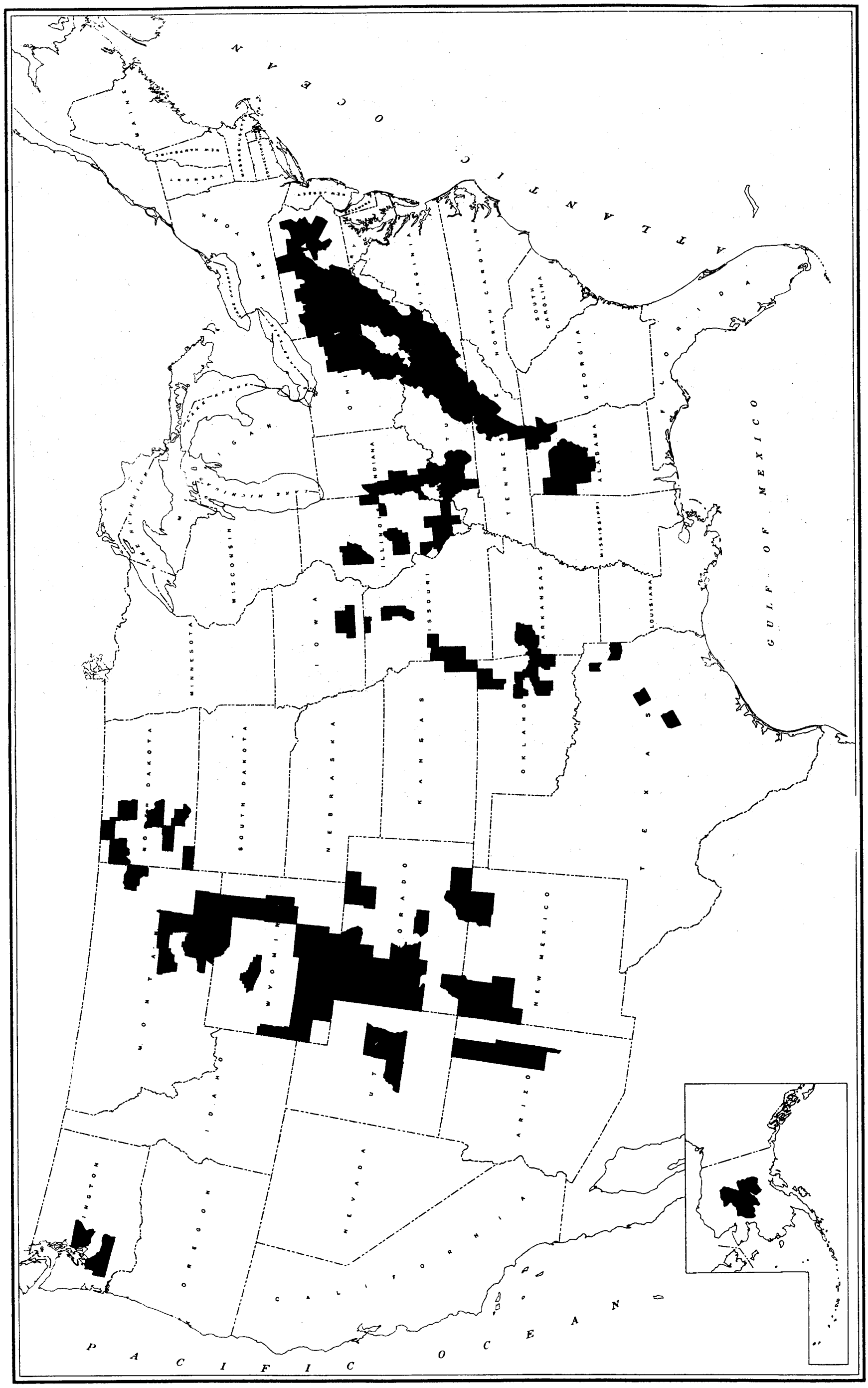

Figure 8.—Coal producing counties in the U.S. in 1975.

Coal-Pennsylvania Anthracite

By Dorothy R. Federoff [1]

All of the reported production of anthracite in 1975 was in northeastern Pennsylvania. The anthracite region is divided geologically into four fields: Eastern Middle, Northern, Southern, and Western Middle. The area is also grouped into three trade regions: Lehigh, Schuylkill, and Wyoming.

The total production in 1975 was 6.2 million short tons, a decrease of 6.3% from that of 1974. The decrease was the result of a miners' strike in April during negotiation of a new wage agreement and the loss of productivity per man-day. Of the total output, 47% was recovered from culm and silt banks, 42% was produced at strip pits, 10% was from underground mines, and approximately 1% was recovered from dredging operations. Compared with tonnages produced in 1974, culm recovery declined 0.6%; strip production, 10.6%; underground production, 2.4%; and the recovery of river coal, 49.3%.

Total value of the 1975 output was $198.5 million, a 37% increase over that of 1974. The average commercial value, f.o.b. preparation plants for all sizes, including dredge coal, was $31.99 per ton, compared with $21.87 per ton in 1974. The average value of pea and larger sizes increased $14.63 per ton (from $30.41 to $45.04), and the average value of buckwheat No. 1 and smaller sizes increased $8.78 per ton (from $18.53 to $27.31).

Apparent consumption of Pennsylvania anthracite in the United States in 1975, calculated as production minus exports (including that exported to West Germany for use by the U.S. Armed Forces), totaled approximately 5.1 million tons, compared with 5.4 million tons in 1974—a decrease of 6%. Overall consumption was as follows: Space heating, 41.7%; electric utilities, 29.0%; coke making, 6.4%; sintering and pelletizing, 4.6%; colliery fuel, 0.2%; and other industrial uses, 18.1%.

According to the U.S. Bureau of Census, exports of anthracite for 1975 totaled 639,601 tons, with a net value of $25.8 million. A 13% decrease in shipments was indicated, compared with 1974 exports. A more complete measurement of exports can be obtained by adding the quantity shipped for use by the U.S. Armed Forces in West Germany to the tonnage reported by the Bureau of Census. This computation indicates that 1,095,293 tons of anthracite was actually exported in 1975, a decrease of 6% from 1974 exports.

The Pennsylvania anthracite-mining industry worked an average of 214 days in 1975 and employed a work force of 3,907. Of that total, 733 were employed at underground mines, 1,468 at strip operations, 400 in the recovery of culm and silt banks, 15 in the dredging operations, and 1,291 at preparation plants and other surface operations. In operation were 109 underground mines, 100 strip pits, 133 culm and silt banks, 8 dredges, and 91 preparation plants.

Although the work force increased 1.6% in 1975, the decline in production was attributable to the strike during April and the loss of productivity per man-day. The productivity rate in average tons per man-day decreased from 7.87 in 1974 to 7.45 in 1975. One fatality occurred in 1975 (two in 1974), and nonfatal injuries increased from 262 in 1974 to 351 in 1975.

The Bureau of Mines publishes a series of weekly and monthly reports containing estimates of production derived primarily

[1] Mineral specialist, Division of Fuels Data.

by factoring data on carloadings furnished by the railroads and monthly truck shipments provided by the Commonwealth of Pennsylvania. The weekly and monthly estimates have been adjusted to the production total for 1975 and are presented in tables 13 and 14. Selected historical data are presented in table 27.

Legislation and Government Programs.—State and Federal Government public-works programs in the environmental area continued throughout 1975, and included control and extinguishment of fires at abandoned underground mines, reclamation of old strip pits and culm banks, and extinguishment of burning coal mine refuse banks. In addition, mine-water control projects were designed to secure the safety and livelihood of mine personnel and to protect anthracite reserves from the hazards of adjoining abandoned mine pools and possible inundation by surface flood waters.

Hydrologic studies were continued to evaluate mine-water problems. These involved determination of the varying heights of underground mine pools, their hydrostatic pressures, and their possible effect on barrier pillars and mine dams protecting active mining operations, and on acid mine-water drainage into surface streams and the unconsolidated valley fill. Under the closely related mine-water control program, a comprehensive series of mine-pool monitoring stations have been installed, and additional phases of the project are proceeding in the Western Middle, and Southern fields.

A program continued for mined-land demonstration activities mainly directed to public health and safety problems associated with mine subsidence. Progress included the adaptation of pressure flushing to larger sized mine refuse materials and efforts to monitor the effectiveness of mine sealing and flushing. Efforts included investigations into the causes and environmental effects of mine subsidence, attempts at early detection, an inventory of cases of subsidence, and development of more economic techniques for controlling and preventing mine subsidence.

The value of the longstanding map-folio program to the public was demonstrated by the numerous requests received by the Bureau of Mines from Federal and local authorities. The requests were for aid in evaluating subsurface conditions to determine subsidence potential for proposed civic improvements and as a cause of possible structural failure in bridges and highways. Work continued on compiling surface and bed maps in stratigraphic sequence for selected areas.

Table 1.—Salient statistics of the Pennsylvania anthracite industry

	1971	1972	1973	1974	1975
Production:					
Preparation plants ---- short tons --	8,323,168	6,618,205	6,377,512	6,454,385	6,117,156
Dredges ---- do ----	389,609	476,792	441,076	150,468	76,142
Use at colleries for power and heat ---- do ----	14,548	11,298	11,373	12,013	10,012
Total production ---- do ----	8,727,325	7,106,295	6,829,961	6,616,866	6,203,310
Value ---- thousands --	$103,469	$85,251	$90,260	$144,695	$198,481
Average sales realization per short ton on preparation-plant shipments (excludes dredge coal):					
Pea and larger ----	$16.39	$17.18	$18.76	$30.41	$45.04
Buckwheat No. 1 and smaller ----	$9.90	$10.14	$11.30	$18.88	$27.61
All sizes ----	$12.08	$12.40	$13.65	$22.19	$32.26
Percentage of total preparation-plant shipments (excludes dredge coal):					
Pea and larger ----	33.6	32.0	31.4	28.8	26.7
Buckwheat No. 1 and smaller ----	66.4	68.0	68.6	71.2	73.3
Exports [1] ---- short tons --	671,024	743,451	716,546	735,173	639,601
Consumption, apparent [2] ---- do ----	7,338,000	5,915,000	5,671,000	5,448,000	5,108,000
Average number of days worked ----	239	216	234	219	214
Average number of men working daily ----	5,800	4,783	4,083	3,847	3,907
Output per man per day ---- short tons --	6.30	6.88	7.15	7.87	7.45
Output per man per year ---- do ----	1,505	1,486	1,673	1,720	1,594
Quantity cut by machines ---- do ----	6,018	--	--	--	--
Quantity mined by stripping ---- do ----	4,478,350	3,483,076	3,278,977	2,868,783	2,563,701
Quantity loaded by machines underground ---- do ----	669,691	593,997	421,202	307,475	298,944
Distribution:					
Exports to Canada [1] ---- do ----	466,039	500,306	477,692	481,345	543,552
Loaded into vessels at Lake Erie [3] ---- do ----	51,402	39,177	19,244	22,965	12,476

[1] U.S. Department of Commerce, 1971–75 export data does not include shipments to U.S. military forces.
[2] Excludes shipments to U.S. Armed Forces.
[3] Ore and Coal Exchange, Cleveland, Ohio.

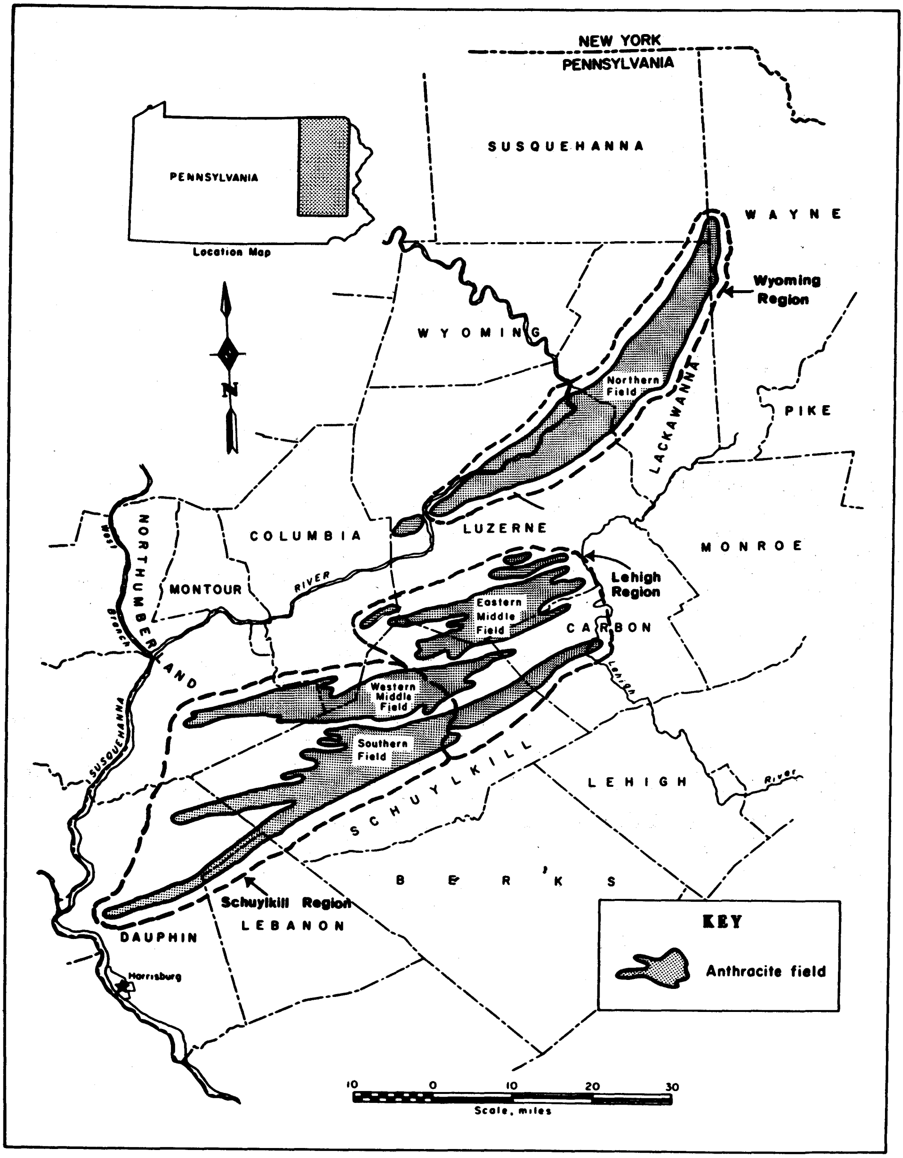

Figure 1.—Coalfields, regions, and counties of the Pennsylvania anthracite area.

DOMESTIC PRODUCTION

Underground production continued to decline because of the health and safety regulations, manpower shortage, and the high cost of pumping water from flooded mines. The output from underground mines in 1975 totaled approximately 641,000 tons, a decrease of 2.4% from that of 1974. The Schuylkill region accounted for 99.1% of the output, and the Wyoming region for the remainder.

Production from strip operations totaled about 2.6 million tons, a decrease of 10.6%. In the Schuylkill region, strip mine production totaled 1.3 million tons, a decrease of 10.0%; in the Lehigh region, 1.1 million tons, a decrease of 11.6%; and in the Wyoming region, 189,000 tons, a decrease of 9.1% from that of 1974.

Culm and silt recovery remained at almost the same level—2,922,000 tons in 1975 (2,940,000 tons in 1974). Of the total, 720,000 tons was recovered in the Lehigh region, an increase of 53.8% over that in 1974, and 710,000 tons was recovered in the Wyoming region, an increase of 63.2%. However, the 1,492,000 tons recovered in the Schuylkill region showed a decline of 26.8% from that of 1974.

Dredging operations produced approximately 76,000 tons in 1975, compared with 150,000 tons in 1974—a drop of 49.3%. Several operations were discontinued because insufficient coal remained in the riverbed to make the salvage operations economically feasible.

Total production in the Lehigh region for 1975 was 6.8% greater than in 1974. A decrease of 11.6% in strip mine production was offset by a 53.8% increase in the recovery of anthracite from culm banks. The Schuylkill region had a decrease in production of 17.6% from that in 1974. Although underground production increased 1.9%, all of the other categories had losses: Strip production, 10.0%; culm bank recovery, 26.8%; and the recovery of river coal, 49.3%. Output in the Wyoming region increased 33.7% over that in 1974. The 63.2% increase in the recovery of anthracite from culm banks compensated for the decreases in underground and strip mine production of 82.4% and 9.1%, respectively.

Mechanical loading of underground anthracite in 1975 declined 2.6% from the 1974 level. However, the loading units dropped 60.4%, owing to the closure of a large underground mine in the Wyoming region. Although the total output of mechanically loaded coal decreased by 8,000 tons from the 1974 output, the percentage that was mechanically loaded remained the same—47%. In operation were 15 scraper loaders, 4 mobile loaders, and 25 conveyor and pit-car loaders.

Equipment used in the stripping operations and culm recovery consisted of 146 front-end loaders, 43 power shovels and 105 draglines—relatively comparable to that in 1974.

The three leading counties in the production of anthracite were Schuylkill County, with a total of 2,997,000 tons; Luzerne County, 1,522,000 tons; and Northumberland County, 798,000 tons. Other counties producing anthracite were Berks, Carbon, Columbia, Dauphin, Lackawanna, Snyder, and Sullivan.

DISTRIBUTION

Reports submitted to the Bureau of Mines by producers, wholesalers, and exporting firms indicated that 5,946,229 short tons of Pennsylvania anthracite was shipped during the 1975 calendar year—a decrease of 4.7% from that of 1974. Where possible, coal used largely for generating electricity and for colliery fuel was eliminated from the statistics. Of the total shipped to market during the year, 81.6% was shipped to points in the United States (a decrease of 4.3% from that in 1974); exports to the Canadian market totaled 543,552 tons, or 9.1% of the total (an increase of 12.9% over 1974 shipments); and exports to countries other than Canada totaled 551,741 tons (a decrease of 19.8% from those in 1974).

In the U.S. market, shipments of pea and larger sizes continued to decline (24.3% in 1975; 12.7% in 1974). In contrast, the demand for industrial sizes continued to increase—3.1% in 1975 compared with 2.3% in 1974. The pea and larger sizes comprised 21.3% of the total distributed (26.9% in 1974), and buckwheat No. 1 and smaller sizes comprised 78.7% of the total (73.1% in 1974). Shipments in the Middle Atlantic States increased 1.1% over those in 1974, but other shipments declined: Those to the New England States, 26.4%; to the South Atlantic States, 48.1%; to the Lake States, 28.0%; and to Other States, 21.6%.

Of the total anthracite distributed, 3,802,641 tons was shipped by truck and the remainder by rail. Additional details of anthracite distribution for 1975 are presented in a Bureau of Mines report.[2]

[2] U.S. Bureau of Mines. Distribution of Pennsylvania Anthracite for the Calendar Year, 1975. Mineral Industry Survey, Oct. 15, 1975, 8 pp.

CONSUMPTION AND USES

Domestic consumption of Pennsylvania anthracite in the United States in 1975, calculated as production minus exports (excluding shipments to the U.S. Armed Forces in West Germany), totaled 5.1 million net tons, compared with 5.4 million tons in 1974—a decrease of 5.6%. Consumption of anthracite for space heating declined 17.4%, principally because of losses to competitive fuels. Consumption of anthracite by the steel industry declined because, throughout most of 1975, steel customers were working their inventories down to levels more in line with their business activities. The process continued into the third quarter, resulting in lower steel-product shipments in 1975, compared with those in the same period in 1974. Overall consumption was as follows: Space heating, 41.7%; electric utilities, 29.0%; coke making, 6.4%; sintering and pelletizing, 4.6%; other industrial uses, 18.1%; and colliery fuel, 0.2%. Although consumption for "other industrial uses" increased 68.2% over that of 1974, declines were indicated in the electric utilities, 1.1%; coke making, 26.6%; sintering and pelletizing, 35.4%; and colliery fuel, 16.7%.

STOCKS

Monthly data on stocks held at retail dealers' yards indicated an inventory of 59,000 tons at yearend 1975, a decrease of 35.2% from that of yearend 1974.

Electric utilities reported an increase of 5.6% in their inventories—982,000 tons at yearend 1975 compared with 930,000 tons at the end of 1974.

Stocks at coke plants totaled 126,000 tons at yearend 1975, a decrease of 26.7% from the 172,000 tons at yearend 1974.

Stocks at Upper Lake Docks (Lake Superior and Lake Michigan) were less than 500 tons at yearend 1975, relatively comparable to those at yearend 1974.

PRICES AND SPECIFICATIONS

Based on total production, including colliery fuel and dredge coal, the average value per ton for 1975 was $31.99 f.o.b. preparation plant, compared with $21.87 per ton in 1974, an increase of 46.3%. The average value per ton of the larger size groups in 1975 was $45.04 f.o.b. preparation plant, an increase of $14.63 from that in 1974. The prices for individual sizes (excluding dredge coal) were as follows: Egg, $45.82 (an increase of $12.91); stove, $46.59 (an increase of $15.05); chestnut, $45.34 (an increase of $14.28); and pea, $42.33 (an increase of $14.72).

The average value of the smaller size groups was $27.61 per ton f.o.b. preparation plant, compared with $18.88 per ton in 1974, an increase of $8.73. The individual prices for the smaller sizes were buckwheat No. 1, $43.50 (an increase of $15.14); buckwheat No. 2 (rice), $39.86 (an increase of $13.13); buckwheat No. 3 (barley), $37.43 (an increase of $14.27); buckwheat No. 4, $33.80 (an increase of $14.45); buckwheat No. 5, $25.74 (an increase of $6.92); and the "other" category, $12.29 (an increase of $3.52).

The Black Diamond magazine quoted wholesale prices f.o.b. preparation plants in 1975 as follows: Egg, stove, and chestnut, $42.50 to $47.50; pea, buckwheat No. 1, and buckwheat No. 2 (rice), $37.50 to $42.50; and buckwheat No. 3 (barley), $35.50 to $42.50.

FOREIGN TRADE

According to the data released by the U.S. Bureau of Census, 639,601 short tons of Pennsylvania anthracite was exported in 1975, a decrease of 13% from that shipped in 1974. Of the total, 85% was exported to Canada (an increase of 12.9% over that shipped in 1974), 1.3% to South America, 0.5% to Asia, and the remainder to other countries. The Census Bureau figures do not include anthracite shipped abroad for the use of U.S. Armed Forces in West Germany; therefore, a more complete measurement of exports can be obtained by adding the military tonnage (455,692 tons) to the tonnage reported by the Bureau of Census. Consequently 1,095,293 tons of anthracite was exported in 1975.

WORLD REVIEW

Complete data on output are not available from all anthracite-producing countries. Some data are only estimates, while other data include coals that, by U.S. standards, are of no higher quality than semianthracite. Despite these inadequacies, the information is sufficiently accurate to indicate general trends. Based on such information, and in full recognition of the margin of error that could exist, it is indicated that total world production in 1975 was 195.2 million tons, an increase of 0.8% over the 193.7 million tons produced in 1974.

The combined output of the U.S.S.R., North Korea, the People's Republic of China, and the Republic of Korea totaled 160.4 million tons, or 82.2% of total world production. Countries registering increases in the production of anthracite include the Republic of Korea, 15.3%; Morocco, 13.6%; North Vietnam, 12.8%; the Republic of South Africa, 10.9%; Spain, 4.4%; North Korea, 2.9%; and the U.S.S.R., 0.4%.

China, People's Republic of.—Coal deposits are known to exist in widespread areas of China, ranging in quality from brown coal through all types of bituminous coal to anthracite. The biggest anthracite producer is Yangchuan, comprising 12 pairs of mine shafts, or 4 to 6 mines, in Shansi Province. Yangchuan increased its production in 1975. The other major anthracite-producing district is Mentoukou. These two major districts combine with other smaller districts to produce 22 million tons of anthracite annually.

Japan.—Production of anthracite in 1975 totaled 101,000 tons, compared with 154,000 tons in 1974—a decrease of 34.4%. Imports totaled 1,131,000 tons, a decline of 32.4% from that of 1974. The principal sources were North Vietnam, 555,183 tons (a decrease of 24.2%); the People's Republic of China, 367,284 tons (a decrease of 9.2%); and Canada, 112,440 tons (a decrease of 24.1%). The total comprised 91.5% of the anthracite imported in 1975. The remainder was imported from North Korea, the Republic of South Korea, the Republic of South Africa, the U.S.S.R., and the United States.

Korea, North.—Output of anthracite totaled 35.0 million tons in 1975, a 2.9% increase over the 34.0 million tons in 1974. Geological prospecting teams reportedly have discovered coal deposits that will play a big role in attaining the 110.0-million-ton coal-output target. Fairly large deposits are located in the Inchon and Ipsok districts. Prior to the recent discovery, coal deposits estimated at tens of millions of tons were discovered in the Tokchon district, south Pyongyang Province. A coalfield is being developed in the Namyang district in the same Province. Anthracite deposits estimated at 8 billion tons are primarily in the vicinity of Pyongyang. Mass movement of coal has an important role in North Korea's rapidly expanding coal industry; consequently, pipes, cableways, and belt conveyors are being introduced in various areas of the coal regions. The latest coal mining project to be completed is the 10-mile cableway.

Mexico.—Virtually all coal reserves lie in the areas of Barrancas, Oaxaca, and Coahuila. Barrancas contains an estimated 22 million tons of coal, predominantly anthracite. The largest consumer of solid fuels in Mexico is the steel industry. As indigenous coal production increases, imports will in all probability decline. Imports of anthracite from the United States in 1975 totaled 12,128 tons, compared with 10,317 tons imported in 1974—an increase of 17.6%.

Morocco.—Production of anthracite in 1975 totaled 719,000 tons, an increase of 13.6% over that of 1974. Despite local unemployment in the past, it has been difficult to recruit labor owing to poor working conditions and wages. At present, mechanization plans are underway that should ultimately help improve these conditions. Although the expansion program is primarily to satisfy domestic requirements, demand for coal is expected to decline in favor of oil. It is therefore possible that limited quantities of anthracite could be made available for export.

Peru.—A survey conducted by Kopex of Poland indicated that coal deposits at Alto Chicama (La Libertad) contain 270 million tons of anthracite, of which 59 million tons are proven reserves. The survey is part of a feasibility study for the development of the reserves and the construction of a 240-megawatt power station at Alto Chicama. Peru produced an estimated 11,000 tons of anthracite in 1975.

South Africa, Republic of.—Output of anthracite in 1975 totaled 1.8 million tons, an increase of 10.9% over that in 1974. The discovery of what is believed to be one of the richest coal deposits in Africa in the Nongoma district of Kwazula, South Africa, has been announced by Ubombo Mines. Investigations reportedly show that the reserves of anthracite will be greater than those of the rest of South Africa combined and could prove to be in excess of 100 million tons.

South Korea, Republic of.—The production of anthracite in 1975 totaled 19.3 million tons, compared with 16.9 million tons in 1974—an increase of 15.3%. South Korea's efforts to exploit indigenous coal reserves to the maximum extent to insure a stable supply of low-cost fuel for household needs will be assisted by the Asian Development Bank. The bank loan is for the foreign exchange component of the Coal Development Project, which consists of the rehabilitation and expansion of coal-production facilities at Dai Han Coal Corp. (DHCC), a wholly Government-owned corporation. The money will be used for overseas purchases of mining equipment, plant, and safety equipment and to cover the services of foreign consultants who will assist in the implementation of the project. The project is expected to be completed by the end of 1978; its aim is to increase DHCC's annual coal production from the current level of about 4.5 million tons to approximately 6.2 million tons in 1979. The Government plans to reduce the country's dependence on imported oil and maximize the development of coal and water power resources, as well as its utilization of atomic energy. The aim is to have coal products account for 34.1% of the total energy supply by the year 1980, an increase of 3.4% over the previous target. Proven coal reserves (predominately anthracite) are currently estimated to be in the range of 546 million tons. At present projected mining rates, the proven reserves are adequate to support coal production for 23 years.

Spain.—Although Spain produced 3.4 million tons of anthracite in 1975, an increase of 4.4% over that of 1974, imports rose from 6,758 tons in 1974 to 19,660 tons in 1975. Of the total, 19,335 tons was imported from the Republic of South Africa and the remainder from the Netherlands.

United Kingdom.—Output of anthracite in 1975 totaled an estimated 2.7 million tons, a decline of 3.3% from the 1974 level. At the large Maesgwyn opencast site, Glynneath, where an estimated 1.5 million tons of anthracite remains to be recovered, an 1,800-ton dragline, with a 247-foot boom and 40-cubic-yard-capacity bucket to remove overburden, is back in operation after a 12-month overhaul. The dragline is the largest in use in South Wales and the second-largest in Britain.

U.S.S.R.—Production of anthracite in 1975 totaled 84 million tons, an increase of 0.5% over that of 1974. The output of anthracite and bituminous coal in the Donetsk Basin is to reach an estimated 231 million to 233 million tons by 1980, and the projected 1985 figure is 245 million tons. Because this region contains vast fields of anthracite and coking coal, the U.S.S.R. will insure an increased output by renovating old mines, reopening new mines, and using highly efficient machines and techniques to increase capacities for coal extraction and processing. Principal recipients of the exports of anthracite are Europe and Japan.

Vietnam, North.—Output of anthracite totaled 4.4 million tons in 1975, an increase of 12.8% over that of 1974. Total known coal reserves, predominately anthracite, are estimated at 2.5 million to 3.0 million tons. The Hon Gai mine, the largest in the country, expects to produce about 4.4 million tons annually. The burgeoning coal export trade is likely to increase the utilization of the port of Hon Gai, although most coal for export is presently handled through Cam Pha. Japan may be importing coal in quantity from Vietnam; exports to Japan in 1975 totaled 555,183 tons.

TECHNOLOGY

The Energy Research and Development Administration (ERDA) is examining the combustibility characteristics of refuse materials from anthracite mining operations and reject streams of preparation cleaning plants in a fluidized-bed combustor at the Morgantown Energy Research Center, Morgantown, W. Va.[3]

The value of this refuse as a fuel is important in the anthracite region because of the decline in mining in the area, which has led to a growing dependence on oil. The burning of this material in fluidized-bed combustors would provide fuel in a region that needs fuel.

The atmospheric-pressure fluidized-bed combustor is basically a refractory-lined cylindrical combustor of 18-inch internal diameter in the bed region, with an expanded freeboard cross section of 24-inch diameter. The combustor is equipped with a horizontal, water-cooled heat exchanger submerged in the bed and a separate water-cooled tube bundle in the freeboard to reduce gas temperature. To control temperature with the low-heating-value refuse fuels, six hairpin loops of ¼-inch 310 stainless steel pipe with individual water-flow controls were installed. Fuel is pneumatically injected into the base of the combustor with room-temperature air. Fluidizing air is provided through a plenum that feeds a number of orifices in the conical distributor. The reject solids that are separated from the exit flue gas by the primary cyclone can be reinjected into the bed with an air injector for carbon burnup. Flue gases are further cleaned by the secondary cyclone and parallel bag filters before exiting through the stack. Gases are sampled for online analysis at the exit of the combustor. Excess spent bed material is withdrawn through the apex of the inverted conical air distributor with a screw feeder.

An operating period with the combustor typically lasts 5 days, 24 hours per day. Startup begins by preheating the empty combustor vessel with a premixed natural gas-air flame through the air distributor. When operating temperature is reached, the fluidized bed is built by feeding either a 50-50 mixture (by weight) of anthracite refuse and inert material (such as limestone) or with the anthracite refuse directly. When the planned bed depth has been achieved, the natural gas flow is curtailed, and the temperature of the bed is stabilized by adjusting water flow in the submerged heat exchanger followed by reinjecting the primary cyclone ash. The complete startup procedure requires 2 to 4 hours from cold lightoff to stabilization of temperatures with normal feeding of refuse and reinjected ash.

Two anthracite refuse materials with widely different characteristics have been burned to date—a fine silt refuse and a much lower quality material from a reworked bank. These refuse materials represent two extremes of fuel quality. The silt approaches anthracite in analysis and heating value, while the reworked refuse bank is much poorer in quality, containing mostly slate and "bone" (laminated coal) and slate agglomerate of medium-carbon value). The fluidized-bed combustor is well suited to burning such materials because of the inherent low carbon in the bed coupled with the good mixing and long residence times used to burn the relatively unreactive carbon found in the two waste materials. Generally, the combustion tests with these refuse materials have demonstrated satisfactory carbon burnout and smooth, sustained operations. The results indicate that the fuel value in the refuse carbon can be easily recovered in a fluidized-bed combustor. Fluidized-bed combustors with waste heat boilers located near the supply of anthracite waste could recover the heating value contained in this reject material and reduce the environmental impact of the refuse piles.

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[3] Wilson, J. S., and D. W. Gilmore. Preliminary Report on Fluid-Bed Combustion of Anthracite Wastes. Pres. at the 4th Internat. Fluidized-Bed Combustion Conf., McLean, Va., Dec. 7–11, 1975; Energy Res. and Devel. Admin., 1975, pp. 1–3.

Table 2.—Standard anthracite specifications approved and adopted by the Anthracite Committee, effective July 28, 1947, and amended July 20, 1953

Size	Round test mesh (inches)	Percent				
		Undersize		Maximum impurities [1]		
		Maximum	Minimum	Slate	Bone	Ash [2]
Broken	Through 4 3/8	--	--	1½	2	11
	Over 3 1/4 to 3	15	7½	--	--	--
Egg	Through 3 1/4 to 3	--	--	1½	2	11
	Over 2 7/16	15	7½	--	3	11
Stove	Through 2 7/16	--	--	2	3	11
	Over 1 5/8	15	7½	--	--	--
Chestnut	Through 1 5/8	--	--	3	4	11
	Over 13/16	15	7½	--	--	--
Pea	Through 13/16	--	--	4	5	12
	Over 9/16	15	7½	--	--	--
Buckwheat No. 1	Through 9/16	--	--	--	--	13
	Over 5/16	15	7½	--	--	--
Buckwheat No. 2 (rice)	Through 5/16	--	--	--	--	13
	Over 3/16	17	7½	--	--	--
Buckwheat No. 3 (barley)	Through 3/16	--	--	--	--	15
	Over 3/32	20	10	--	--	--
Buckwheat No. 4	Through 3/32	--	--	--	--	15
	Over 3/64	30	10	--	--	--
Buckwheat No. 5	Through 3/64	NL	NL	--	--	16

NL No limit.

[1] When slate content in sizes from broken to chestnut, inclusive, is less than above standards, bone content may be increased by 1½ times the decrease in slate content under the allowable limits, but slate content specified above shall not be exceeded in any event.

A tolerance of 1% is allowed on maximum percentage of undersize and maximum percentage of ash content.

Maximum percentage of undersize is applicable only to anthracite as it is produced at preparation plant.

Slate is defined as any material that has less than 40% fixed carbon.

Bone is defined as any material that has 40% or more, but less than 75%, fixed carbon.

[2] Ash determinations are on a dry basis.

Table 3.—Project report

Project location	Project description	Sponsor	Status of report
	ACID COAL MINE DRAINAGE		
Anthracite fields	Monthly measurements of mine water levels and overflows.	U.S. Geological Survey and U.S. Bureau of Mines.	Continuous.
Columbia, Northumberland, Schuylkill Counties.	Mine Drainage Project No. 46, Phase D, construction of mine water pool monitoring stations.	U.S. Bureau of Mines and Commonwealth of Pennsylvania.	Work completed in 1975.
Carbon, Dauphin, Schuylkill Counties.	Mine Drainage Project No. 46, Phase E.	do	Work started in 1975.
Schuylkill County, Rausch Creek.	General construction of treatment plant.	Commonwealth of Pennsylvania.	Work completed in 1975.
Lackawanna County, Lackawanna River and Mayfield Hosey Run.	Restoration	do	Do.
	SURFACE SUBSIDENCE		
Lackawanna County:			
Carbondale West	Appalachian subsidence control, project No. 8.	Commonwealth of Pennsylvania and U.S. Bureau of Mines.	Work completed in 1975.
Dickson City	Subsidence control, backfilling	U.S. Bureau of Mines.	Work started in 1975.
Olyphant Borough	Demonstration project for hydraulic backfilling into inaccessible mine voids to establish limitations in the use of the pumped slurry.	do	Work in progress in 1975.

Table 3.—Project report—Continued

Project location	Project description	Sponsor	Status of report
	SURFACE SUBSIDENCE—Continued		
Lakawanna County—Continued			
Scranton:			
Green Ridge section.	Demonstration project for filling mine voids under approximately 35 acres.	U.S. Bureau of Mines	Work started in 1972; completed in 1975.
Hill section	Filling abandoned mine voids	U.S. Bureau of Mines and Commonwealth of Pennsylvania.	Work in progress in 1975.
Minooka section.	Filling mine voids. Blind-flushing approximately 17 acres of a pilot demonstration project.	do	Work completed in 1975.
Southside section.	Hydraulic flushing of mine voids, project No. 11.	do	Work in progress in 1975.
Luzerne County:			
Pittson	Subsidence control	do	Work started in 1975.
	UNDERGROUND MINE FIRES		
Lakawanna County:			
Eddy Creek, Boroughs of Throop and Olyphant.	Mine fire control using a pumped slurry backfilling method of burned breaker refuse.	U.S. Bureau of Mines.	Work completed in 1975.
Columbia County:			
Centralia Borough	Appalachian mine fire control, including exploratory drilling and underground barrier pillars formed by injecting fly ash into mine voids.	U.S. Bureau of Mines and Commonwealth of Pennsylvania.	Work continues in 1975.
	SURFACE MINE RECLAMATION PROJECTS		
Lackawanna County:			
Scranton:			
Cedar Avenue	Revegetation project of barren mine lands, research demonstration.	U.S. Bureau of Mines and Commonwealth of Pennsylvania.	Work completed in 1975.
Taylor Borough	Keyser Valley strip mine area reclamation, demonstration project.	do	do
Luzerne County:			
Preston	Refuse-bank reclamation demonstration project on the feasibility of using anthracite fly ash with lime, grass seeds, and legumes to vegetate the surface. Project is under the direction of the Energy Research and Development Administration at Morgantown, W. Va.	do	do

Table 4.—Summary of monthly developments in the Pennsylvania anthracite industry in 1975
(Thousand short tons, except as otherwise indicated)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1975	Change from 1974 (percent)	Total 1974
Production (including mine fuel, local sales, dredge coal)	540	535	544	270	535	544	455	535	500	560	555	630	6,203	−6.3	6,617
Shipments (breakers and washeries only, all sizes):															
By rail [1]	198	193	195	65	201	190	187	203	190	169	153	129	2,073	−31.3	3,019
By truck [2]	314	358	284	193	248	293	259	306	281	318	222	524	3,600	−8.1	3,917
Carloadings [3] (thousand cars)	3	3	3	1	3	3	3	3	3	3	2	2	32	−18.0	39
Distribution:															
Lake Erie loadings [4]	--	--	--	--	2	2	--	3	2	3	--	--	12	−47.8	23
Upper Lake dock trade: [5]															
Receipts	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	2	--	2
Deliveries (reloadings)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	1	−50.0	2
Exports [7]	39	44	32	68	15	66	89	45	102	56	21	63	640	−12.9	735
Industrial consumption and stocks by—															
Electric utilities: [8]															
Consumption	138	121	110	115	144	129	119	130	119	120	120	117	1,482	−1.1	1,498
Stocks	920	915	946	937	968	952	985	1,003	1,006	1,030	1,030	982	982	+5.6	930
Coke plants:															
Used for carbonizing	30	29	33	27	25	22	26	26	26	29	27	28	328	−26.1	444
Stocks	171	165	159	145	135	131	125	127	128	129	133	126	126	−26.7	172
Stocks on Upper Lake docks: [5]															
Lake Superior	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lake Michigan	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	--	(6)
Stocks in retail dealer yards: [9]															
Chestnut and larger	61	62	72	74	63	52	47	37	34	35	31	47	47	−30.9	68
Pea	7	4	3	2	2	2	2	2	3	2	2	1	1	−85.7	7
Buckwheat No. 1 and rice	16	15	16	14	14	15	13	13	12	11	11	11	11	−31.3	16
Total	84	81	91	90	79	69	62	52	49	48	44	59	59	−35.2	91
Retail dealer deliveries: [9]															
Chestnut and larger	12	12	13	18	9	7	12	14	16	14	8	11	146	−54.5	321
Pea	46	40	61	24	11	17	13	15	13	14	8	12	274	−29.7	390
Buckwheat No. 1 and rice	51	49	62	54	51	59	39	51	66	45	47	56	630	+94.4	324
Total	109	101	136	96	71	83	64	80	95	73	63	79	1,050	+1.5	1,035
Wholesale price indexes, f.o.b. car at mines (1957–59 = 100): [10]															
Chestnut	319.0	319.0	319.0	319.0	355.0	365.0	365.0	355.0	355.0	355.0	355.0	355.0	344.7	+50.4	229.2
Buckwheat No. 1	378.9	378.9	384.6	384.6	427.5	427.5	427.5	427.5	427.5	427.0	427.0	440.0	418.3	+52.6	270.8

See footnotes on next page.

[1] Furnished by initial carriers.
[2] Pennsylvania Department of Mines and Mineral Industries.
[3] Association of American Railroads.
[4] Ore and Coal Exchange, Cleveland, Ohio.
[5] Data furnished by Lake dock operators.
[6] Less than ½ unit.
[7] U.S. Department of Commerce. Does not include shipments to the U.S. military forces.
[8] Federal Power Commission.
[9] Estimated from reports submitted by a selected list of retail dealers located outside the producing region.
[10] Furnished by the Bureau of Labor Statistics from data obtained from authorized trade publications.

NOTE.—According to the Association of American Railroads, 582,185 short tons of anthracite were exported to Europe during 1975, compared with 589,174 short tons for 1974. Of this total 510,577 short tons were consigned to West Germany and the Netherlands including exports to the U.S. military forces. This compares with 412,611 short tons for 1974.

Table 5.—Commercial production of Pennsylvania anthracite in 1975, by region and size

	From preparation plants												From river dredging			Total [2]		
	Lehigh region			Schuylkill region			Wyoming region [1]			Total preparation plants [2]								
	Rail	Truck	Total [2]	Rail	Truck	Total [2]	Rail	Truck	Total [2]	Rail	Truck	Total	Rail	Truck	Total [2]	Rail	Truck	Total
Quantity, thousand short tons:																		
Lump and broken	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Egg	99	2	101	1	(3)	2	13	1	14	114	4	117	--	--	--	114	4	117
Stove	187	31	218	176	115	291	20	7	27	384	153	537	--	--	--	384	153	537
Chestnut	101	100	202	143	189	331	13	29	41	257	318	575	--	--	--	257	318	575
Pea	26	87	112	73	170	242	3	46	49	101	302	404	--	--	--	101	302	404
Total pea and larger [2]	413	220	633	393	474	867	50	83	133	856	777	1,633	--	--	--	856	777	1,633
Buckwheat No. 1	92	90	183	105	199	303	11	82	93	208	371	579	--	--	--	208	371	579
Buckwheat No. 2 (rice)	21	132	153	46	239	284	3	83	86	70	453	523	--	--	--	70	453	523
Buckwheat No. 3 (barley)	57	104	161	148	257	404	6	114	119	210	475	685	--	--	--	210	475	685
Buckwheat No. 4	51	35	86	137	126	263	4	61	65	191	223	414	--	--	--	191	223	414
Buckwheat No. 5	135	54	189	247	283	531	13	19	32	396	356	752	--	--	--	396	356	752
Other [4]	14	354	368	25	762	787	21	356	377	61	1,472	1,533	1	75	76	62	1,547	1,609
Total buckwheat No. 1 and smaller [2]	371	769	1,140	708	1,865	2,573	57	714	772	1,136	3,349	4,485	1	75	76	1,137	3,425	4,562
Grand total [2]	784	989	1,773	1,100	2,339	3,439	107	797	905	1,991	4,126	6,117	1	75	76	1,992	4,201	6,193

Value, thousands:																		
Lump and broken	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Egg	4,519	88	4,607	77	11	88	610	60	670	5,206	159	5,366	--	--	--	5,206	159	5,366
Stove	8,672	1,453	10,124	8,330	5,273	13,603	956	333	1,288	17,958	7,058	25,015	--	--	--	17,958	7,058	25,015
Chestnut	4,526	4,536	9,062	6,649	8,466	15,115	585	1,294	1,879	11,760	14,296	26,056	--	--	--	11,760	14,296	26,056
Pea	1,050	3,588	4,638	3,336	7,094	10,430	127	1,895	2,022	4,513	12,577	17,090	--	--	--	4,513	12,577	17,090
Total pea and larger [2]	18,767	9,665	28,431	18,393	20,844	39,237	2,277	3,582	5,859	39,437	34,090	73,527	--	--	--	39,437	34,090	73,527
Buckwheat No. 1	4,003	3,947	7,950	5,077	8,307	13,384	472	3,374	3,847	9,553	15,628	25,181	--	--	--	9,553	15,628	25,181
Buckwheat No. 2 (rice)	855	5,221	6,076	1,982	9,406	11,387	111	3,267	3,378	2,948	17,893	20,841	--	--	--	2,948	17,893	20,841
Buckwheat No. 3 (barley)	2,336	3,846	6,181	6,154	9,588	15,742	240	3,470	3,710	8,730	16,903	25,633	--	--	--	8,730	16,903	25,633
Buckwheat No. 4	1,912	1,194	3,106	5,665	3,420	9,085	124	1,668	1,792	7,701	6,282	13,984	--	--	--	7,701	6,282	13,984
Buckwheat No. 5	4,393	1,587	5,980	6,844	5,645	12,489	446	431	877	11,683	7,663	19,346	--	--	--	11,683	7,663	19,346
Other [4]	270	4,246	4,516	529	8,854	9,383	428	4,500	4,929	1,227	17,601	18,827	10	751	761	1,237	18,352	19,588
Total buckwheat No. 1 and smaller [2]	13,769	20,041	33,810	26,250	45,220	71,470	1,822	16,710	18,532	41,841	81,971	123,812	10	751	761	41,852	82,722	124,573
Grand total [2]	32,536	29,706	62,241	44,643	66,064	110,707	4,099	20,292	24,391	81,278	116,061	197,339	10	751	761	81,288	116,812	198,101
Average value per ton: [5]																		
Lump and broken	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Egg	45.70	45.28	45.70	54.44	47.94	53.56	45.87	45.00	45.79	45.83	45.34	45.82	--	--	--	45.83	45.34	45.82
Stove	46.35	46.45	46.37	47.32	45.72	46.69	46.73	48.93	47.28	46.82	46.01	46.59	--	--	--	46.82	46.01	46.59
Chestnut	44.60	45.25	44.92	46.60	44.84	45.60	45.56	45.15	45.28	45.76	45.00	45.34	--	--	--	45.76	45.00	45.34
Pea	40.84	41.41	41.28	45.95	41.84	43.07	40.98	41.05	41.04	44.50	41.60	42.33	--	--	--	44.50	41.60	42.33
Total pea and larger	45.42	43.91	44.90	46.83	43.98	45.27	45.84	43.17	44.17	46.09	43.88	45.04	--	--	--	46.09	43.88	45.04
Buckwheat No. 1	43.47	43.63	43.55	48.50	41.82	44.13	43.87	41.03	41.36	46.03	42.08	43.50	--	--	--	46.03	42.08	43.50
Buckwheat No. 2 (rice)	39.95	39.63	39.67	43.52	39.42	40.08	40.16	39.43	39.46	42.29	39.48	39.86	--	--	--	42.29	39.48	39.86
Buckwheat No. 3 (barley)	40.91	36.89	38.31	41.68	37.36	38.94	42.55	30.53	31.10	41.49	35.62	37.43	--	--	--	41.49	35.62	37.43
Buckwheat No. 4	37.71	34.10	36.23	41.43	27.11	34.56	33.77	27.16	27.53	40.30	28.23	33.80	--	--	--	40.30	28.23	33.80
Buckwheat No. 5	32.51	29.29	31.59	27.65	19.95	23.54	33.71	23.11	27.51	29.51	21.54	25.74	--	--	--	29.51	21.54	25.74
Other [4]	19.09	12.00	12.27	20.73	11.62	11.92	20.00	12.65	13.07	20.10	11.96	12.29	10.00	10.00	10.00	19.93	12.18	12.18
Total buckwheat No. 1 and smaller	37.16	26.04	29.66	37.10	24.25	27.78	31.69	23.39	24.01	36.84	24.48	27.61	10.00	10.00	10.00	36.82	24.16	27.31
Grand total	41.52	30.02	35.10	40.57	28.25	32.19	38.25	25.45	26.96	40.82	28.13	32.26	10.00	10.00	10.00	40.80	27.81	31.99

[1] Includes Sullivan County.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than 1,000 short tons.
[4] Includes various mixtures of buckwheat Nos. 2 to 5 and coal of relatively low dollar value.
[5] Average value derived from actual rather than rounded data.

Table 6.—Sizes of Pennsylvania anthracite (excluding dredge coal) prepared at plants, by region

(Percent)

Size	1971	1972	1973	1974	1975	1971	1972	1973	1974	1975
	Lehigh region					Schuylkill region				
Lump and broken	--	--	--	--	--	--	--	--	--	--
Egg	4.6	2.4	4.6	5.4	5.7	0.9	0.3	0.3	0.1	(1)
Stove	10.9	10.8	12.9	14.4	12.3	10.4	10.2	9.1	7.6	8.5
Chestnut	11.0	10.6	9.9	12.8	11.4	10.7	10.1	9.4	8.6	9.6
Pea	9.9	8.5	8.5	9.9	6.3	7.4	6.9	6.8	6.5	7.0
Total pea and larger	36.4	32.3	35.9	42.5	35.7	29.4	27.5	25.6	22.8	25.2
Buckwheat No. 1	10.6	12.1	11.3	12.1	10.3	10.2	9.0	8.7	7.5	8.8
Buckwheat No. 2 (rice)	10.7	9.0	9.0	11.3	8.6	8.9	8.8	8.3	7.5	8.3
Buckwheat No. 3 (barley)	10.1	9.1	9.4	11.1	9.1	12.7	12.2	11.2	10.2	11.8
Buckwheat No. 4	5.6	5.9	5.6	5.9	4.8	9.6	10.3	8.5	7.3	7.6
Buckwheat No. 5	12.1	14.5	14.5	16.0	10.7	20.4	22.0	20.4	20.3	15.4
Other [2]	14.5	17.1	14.3	1.1	20.8	8.8	10.2	17.3	24.4	22.9
Total buckwheat No. 1 and smaller	63.6	67.7	64.1	57.5	64.3	70.6	72.5	74.4	77.2	74.8
	Wyoming region					Total				
Lump and broken	(1)	--	--	--	--	(1)	--	--	--	--
Egg	1.9	1.7	2.1	1.9	1.6	2.1	1.1	1.7	1.6	1.9
Stove	13.0	13.6	14.1	6.8	3.0	11.1	11.0	11.0	9.3	8.8
Chestnut	12.7	15.6	13.8	14.0	4.6	11.2	11.4	10.2	10.3	9.4
Pea	12.7	12.9	14.4	8.3	5.4	9.2	8.5	8.5	7.6	6.6
Total pea and larger	40.3	43.8	44.4	31.0	14.6	33.6	32.0	31.4	28.8	26.7
Buckwheat No. 1	17.1	16.4	15.9	7.8	10.3	11.8	11.2	10.7	8.7	9.5
Buckwheat No. 2 (rice)	8.8	9.8	9.1	5.5	9.5	9.3	9.1	8.6	8.2	8.5
Buckwheat No. 3 (barley)	11.0	11.5	13.1	11.8	13.2	11.6	11.3	11.0	10.6	11.2
Buckwheat No. 4	4.3	4.4	5.4	10.3	7.2	7.4	8.0	7.2	7.2	6.8
Buckwheat No. 5	3.4	2.5	2.7	1.2	3.5	14.6	16.1	15.9	17.2	12.3
Other [2]	15.1	11.6	9.4	32.4	41.7	11.7	12.3	15.2	19.3	25.0
Total buckwheat No. 1 and smaller	59.7	56.2	55.6	69.0	85.4	66.4	68.0	68.6	71.2	73.3

[1] Less than 0.5%.
[2] Includes various mixtures of buckwheat Nos. 2 to 5 and coal of relatively low dollar value.

Table 7.—Production of Pennsylvania anthracite in 1975, by region and county
(Thousand short tons and thousand dollars)

Source	Rail shipments		Truck shipments		Colliery fuel		Total production [1]	
	Quantity	Value [2]	Quantity	Value [2]	Quantity	Value	Quantity	Value [2]
REGION								
Lehigh:								
Preparation plants	784	32,536	990	29,705	4	167	1,778	62,408
Schuylkill:								
Preparation plants	1,100	44,643	2,339	66,064	5	202	3,445	110,909
Dredges	1	10	75	751	--	--	76	761
Total Schuylkill	1,101	44,653	2,414	66,815	5	202	3,521	111,670
Wyoming:								
Preparation plants [3]	107	4,099	797	20,292	(4)	11	905	24,402
Total: [1]								
Preparation plants	1,991	81,278	4,126	116,061	10	380	6,127	197,719
Dredges	1	10	75	751	--	--	76	761
Grand total [1]	1,992	81,288	4,201	116,812	10	380	6,203	198,481
COUNTY								
Berks and Snyder	1	10	50	502	--	--	51	512
Carbon	60	2,494	399	5,155	--	--	460	7,649
Columbia	4	134	55	1,670	--	--	59	1,804
Dauphin	--	--	34	867	--	--	34	867
Lackawanna	9	382	234	8,938	(4)	10	243	9,330
Luzerne	562	23,247	956	29,274	4	151	1,522	52,672
Northumberland	183	7,327	614	15,287	1	30	798	22,644
Schuylkill	1,174	47,694	1,819	54,569	5	189	2,997	102,452
Sullivan	--	--	40	551	--	--	40	551
Total [1]	1,992	81,288	4,201	116,812	10	380	6,203	198,481

[1] Data may not add to totals shown because of independent rounding.
[2] Value given for shipments is that at which coal left possession of producing company; does not include selling expenses.
[3] Includes Sullivan County.
[4] Less than 1,000 short tons.

Table 8.—Pennsylvania anthracite produced, by field
(Thousand short tons)

Field	1971	1972	1973	1974	1975
Eastern Middle: Breakers and washeries	1,519	1,221	1,288	1,156	1,170
Western Middle:					
Breakers and washeries	2,167	1,741	1,663	1,939	1,451
Dredges	W	W	W	W	W
Total	W	W	W	W	W
Southern:					
Breakers and washeries	2,849	2,333	2,427	2,693	2,602
Dredges	W	W	W	W	W
Total	W	W	W	W	W
Northern: Breakers and washeries [1]	1,802	1,334	1,011	677	905
Total:					
Breakers and washeries	8,337	6,629	6,389	6,466	6,127
Dredges	390	477	441	150	76
Grand total	8,727	7,106	6,830	[2] 6,617	6,203

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Sullivan County.
[2] Data do not add to total shown because of independent rounding.

Table 9.—Pennsylvania anthracite produced in 1975, classified as fresh-mined, culm-bank, and river coal, by field and region

(Thousand short tons)

Source	Fresh-mined coal				From culm banks	From river dredging	Total [1]
	Underground mines			Strip pits			
	Mechanically loaded	Hand loaded	Total				
FIELD							
Eastern Middle	--	--	--	821	349	--	1,170
Western Middle	40	67	107	475	869	W	W
Southern	253	275	528	1,079	994	W	W
Northern [2]	6	(3)	6	189	710	--	905
Total [1]	299	342	641	2,564	2,922	76	6,203
REGION							
Lehigh	--	--	--	1,057	720	--	1,777
Schuylkill	293	342	635	1,318	1,492	76	3,521
Wyoming	6	(3)	6	189	710	--	905
Total	299	342	641	2,564	2,922	76	6,203

W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.
[2] Includes Sullivan County.
[3] Less than 1,000.

Table 10.—Production of Pennsylvania anthracite from strip pits

	Mined by stripping (thousand short tons)	Percentage of fresh-mined total	Number of men employed	Average number of days worked
1971	4,478	77.7	1,800	273
1972	3,483	78.7	2,011	261
1973	3,279	81.9	1,633	250
1974	2,869	81.4	1,376	244
1975:				
Lehigh region	1,057	33.0	NA	NA
Schuylkill region	1,318	41.1	NA	NA
Wyoming region [1]	189	5.8	NA	NA
Total or average	2,564	79.9	1,468	213

NA Not available.
[1] Includes Sullivan County.

Table 11.—Power shovels, front-end loaders, and draglines used in recovering coal from culm banks and stripping Pennsylvania anthracite, by type of power

Type of power	1973				1974				1975			
	Number of front-end loaders	Number of power shovels	Number of drag-lines	Total	Number of front-end loaders	Number of power shovels	Number of drag-lines	Total	Number of front-end loaders	Number of power shovels	Number of drag-lines	Total
Gasoline	--	--	1	1	--	2	2	4	--	4	1	5
Electric	--	16	34	50	--	14	30	44	--	13	27	40
Diesel	138	34	77	249	146	27	73	246	179	38	98	315
Diesel-electric	--	--	--	--	--	--	--	--	--	1	1	2
Total	138	50	112	300	146	43	105	294	179	56	127	362

Table 12.—Production of Pennsylvania anthracite from culm banks, by region

(Thousand short tons)

Year	Lehigh region	Schuylkill region	Wyoming region	Total
1971	729	1,544	300	2,573
1972	614	1,411	177	2,202
1973	611	1,612	161	2,384
1974	468	2,037	435	2,940
1975	720	1,492	710	2,922

Table 13.—Estimated production of Pennsylvania anthracite in 1975, by week [1]

Week ended—	Thousand short tons	Week ended—	Thousand short tons	Week ended—	Thousand short tons
Jan. 4	70	May 17	144	Sept. 13	126
11	140	24	124	20	136
18	105	31	108	27	91
25	110	June 7	136	Oct. 4	107
Feb. 1	115	14	116	11	146
8	148	21	126	18	131
15	138	28	151	25	111
22	117	July 5	50	Nov. 1	106
Mar. 1	132	12	70	8	142
8	156	19	150	15	136
15	121	26	114	22	142
22	126	Aug. 2	106	29	135
29	121	9	125	Dec. 6	158
Apr. 5	80	17	154	13	145
12	35	23	116	20	139
19	35	30	120	27	109
26	40	Sept. 6	106	Jan. 3 [2]	79
May 3	120				
10	139			Total	6,203

[1] Estimated from weekly carloadings as reported by the Association of American Railroads and other factors; adjusted to annual production from Bureau of Mines canvass.
[2] Figures represent production in that part of week included in calendar year shown.

Table 14.—Estimated monthly production of Pennsylvania anthracite [1]

(Thousand short tons)

Month	1971	1972	1973	1974	1975
January	725	583	522	516	540
February	654	542	568	458	535
March	780	622	641	531	544
April	795	487	581	563	270
May	782	706	641	589	535
June	740	515	609	505	544
July	620	465	434	443	455
August	813	688	587	620	535
September	767	611	532	516	500
October	710	682	614	641	560
November	685	650	582	610	555
December	656	555	519	625	630
Total	8,727	7,106	6,830	6,617	6,203

[1] Production is estimated from weekly carloadings, as reported by the Association of American Railroads, and includes mine fuel, coal sold locally, and dredge coal.

Table 15.—Pennsylvania anthracite loaded mechanically underground
(Thousand short tons)

Year	Scraper loaders		Mobile loaders		Conveyor and pit-car loaders		Total loaded mechanically[1]	
	Number of units	Quantity loaded	Number of units	Quantity loaded	Number of units	Quantity loaded	Number of units	Quantity loaded
1971	95	319	18	151	91	199	204	670
1972	81	347	16	136	46	111	143	594
1973	72	220	4	106	47	96	123	421
1974	64	89	6	169	41	49	111	307
1975	15	66	4	188	25	44	44	299

[1] Data may not add to totals shown because of independent rounding.

Table 16.—Trends in mechanical loading,[1] hand loading, stripping of Pennsylvania anthracite, fresh-mined coal
(Thousand short tons)

Year	Underground					Strip pits		
	Mechanical loading	Percentage of total underground	Hand loading	Percentage of total underground	Total	Quantity	Percentage of fresh-mined coal	Total
1971	670	52.1	617	47.9	1,287	4,478	77.7	5,765
1972	594	62.9	350	37.1	944	3,483	78.7	4,427
1973	421	58.0	305	42.0	726	3,279	81.9	4,005
1974	307	46.8	350	53.2	657	2,869	81.4	3,526
1975	299	46.6	342	53.4	641	2,564	80.0	3,205

[1] Mechanical loading includes coal handled on pit-car loaders and hand-loaded face conveyors.

Table 17.—Average sales realization of Pennsylvania anthracite (excluding dredge coal) at preparation plants, by region and size

(Per short ton)

Size	1971	1972	1973	1974	1975	1971	1972	1973	1974	1975
	Lehigh region					Schuylkill region				
Lump[1] and broken	--	--	--	--	--	$6.00	--	--	--	--
Egg	$17.59	$18.32	$19.77	$33.23	$45.70	16.83	$16.58	$17.32	$33.85	$53.56
Stove	16.62	17.67	19.37	30.96	46.37	16.65	17.56	19.35	32.23	46.29
Chestnut	16.47	17.39	19.11	30.04	44.92	16.58	17.23	18.96	32.38	45.60
Pea	14.60	15.60	16.36	27.02	41.28	15.00	15.33	16.86	28.40	43.07
Total pea and larger	16.14	17.08	18.64	30.05	44.90	16.21	16.87	18.52	31.20	45.27
Buckwheat No. 1	14.55	15.29	16.87	29.35	43.55	14.77	14.85	16.00	27.77	44.13
Buckwheat No. 2 (rice)	14.33	15.06	16.89	26.56	39.67	14.45	14.95	16.34	26.74	40.08
Buckwheat No. 3 (barley)	12.71	13.82	14.99	23.80	38.31	12.30	12.36	13.82	23.11	38.94
Buckwheat No. 4	8.51	8.82	10.68	19.20	36.23	8.00	9.15	10.87	20.53	34.56
Buckwheat No. 5	6.64	6.28	8.49	20.51	31.59	5.88	5.71	8.34	18.33	23.54
Other[2]	4.04	4.81	5.13	6.25	12.27	3.50	4.70	5.83	8.41	11.92
Total buckwheat No. 1 and smaller	9.78	10.09	11.55	23.78	29.66	9.39	9.43	10.66	17.76	27.78
Grand total	12.10	12.35	14.09	26.45	35.10	11.40	11.48	12.67	20.81	32.19
	Wyoming region[3]					Total				
Lump[1] and broken	--	--	--	--	--	6.00	--	--	--	--
Egg	19.29	18.46	19.88	30.46	45.79	17.76	18.11	19.55	32.91	45.82
Stove	16.67	18.13	20.08	29.95	47.28	16.65	17.73	19.51	31.54	46.59
Chestnut	17.56	18.63	20.36	28.40	45.28	16.79	17.66	19.30	31.06	45.34
Pea	16.30	16.38	17.82	25.56	41.04	15.28	15.72	16.98	27.61	42.33
Total pea and larger	16.96	17.81	19.42	28.10	44.17	16.39	17.18	18.76	30.41	45.04
Buckwheat No. 1	15.15	16.23	17.46	28.02	41.36	14.83	15.38	16.60	28.36	43.50
Buckwheat No. 2 (rice)	15.17	15.60	17.93	27.57	39.46	14.56	15.12	16.77	26.73	39.86
Buckwheat No. 3 (barley)	13.13	13.87	13.91	21.92	31.10	12.56	12.97	14.11	23.16	37.43
Buckwheat No. 4	7.78	9.39	10.40	14.48	27.53	8.07	9.11	10.78	19.35	33.80
Buckwheat No. 5	6.61	7.22	8.96	14.01	27.51	6.08	5.93	8.39	18.82	25.74
Other[2]	6.24	6.60	7.15	10.66	13.07	4.44	5.16	5.78	8.77	12.29
Total buckwheat No. 1 and smaller	11.50	12.71	13.85	16.51	24.01	9.90	10.14	11.30	18.88	27.61
Grand total	13.70	14.94	16.33	20.11	26.96	12.08	12.40	13.65	22.19	32.26

[1] Value of lump included is insignificant.
[2] Includes various mixtures of buckwheat Nos. 2 to 5 and coal of relatively low dollar value.
[3] Includes Sullivan County.

Table 18.—Average value of Pennsylvania anthracite from all sources, by region[1]
(Per net ton)

Region	1974 Shipped by rail	1974 Shipped by truck	1974 Colliery fuel	1974 Total	1975 Shipped by rail	1975 Shipped by truck	1975 Colliery fuel	1975 Total
Lehigh	$27.11	$25.79	$26.05	$26.45	$41.52	$30.02	$38.91	$35.11
Schuylkill	23.84	18.71	22.53	20.36	40.54	27.68	36.86	31.72
Wyoming[2]	22.27	19.28	21.95	20.11	38.25	25.45	46.89	26.97
Total	24.85	20.18	23.64	21.87	40.80	27.81	37.97	31.99

[1] Value given for shipments is that at which coal left possession of producing company; does not include selling expenses.
[2] Includes Sullivan County.

Table 19.—Wholesale prices of Pennsylvania anthracite in 1975, by size[1]
(Per short ton)

Size	Winter	Spring	Summer-Fall	End of year
Egg and stove	$42.50–$43.00	$47.25–$47.50	$47.25–$47.50	$47.25–$47.50
Chestnut	42.50– 42.75	47.00– 47.50	47.00– 47.50	47.00– 47.50
Pea	37.50	42.00– 42.50	42.00– 42.50	42.00– 42.50
Buckwheat No. 1	37.50	42.00– 42.50	42.00– 42.50	42.00– 42.50
Buckwheat No. 2 (rice)	37.50	42.00– 42.50	42.00– 42.50	42.00– 42.50
Buckwheat No. 3 (barley)	35.50– 36.50	42.00– 42.50	42.00– 42.50	42.00– 42.50

[1] As quoted in the Black Diamond Magazine. All prices are per short ton f.o.b. at mines.

Table 20.—Employment at operations producing Pennsylvania anthracite (including strip contractors) in 1975

	Lehigh region	Schuylkill region	Wyoming region[1]	Total 1975 p	Total 1974
Average number of men working per day:					
Underground	NA	NA	NA	733	594
Strip	NA	NA	NA	1,468	1,376
Culm banks	NA	NA	NA	400	390
Preparation plants	NA	NA	NA	1,291	1,366
Other surface	NA	NA	NA	(2)	101
Total, excluding dredge operations	NA	NA	NA	3,892	3,827
Dredge operations	NA	NA	NA	15	20
Total	NA	NA	NA	3,907	3,847
Average number of days active:					
All operations except dredges	NA	NA	NA	213	218
Dredge operations	NA	NA	NA	275	300
Average, all operations	NA	NA	NA	214	219
Man-days of labor:					
All operations except dredges	NA	NA	NA	829,000	834,000
Dredge operations	NA	NA	NA	4,000	6,000
Total, all operations	NA	NA	NA	833,000	840,000
Average tons per man-day:					
All operations except dredges	NA	NA	NA	7.39	7.75
Dredge operations	NA	NA	NA	18.46	25.08
Average, all operations	NA	NA	NA	7.45	7.87

p Preliminary. NA Not available.
[1] Includes Sullivan County.
[2] Included in above operations.

Table 21.—Distribution of Pennsylvania anthracite, calendar year 1975, by State, Province, or country of destination

(Short tons)

Destination	Pea and larger					Buckwheat No. 1 and smaller					Total all sizes
	Broken and egg	Stove	Chestnut	Pea	Total	Buckwheat No. 1	Buckwheat No. 2 (Rice)	Buckwheat No. 3 (Barley)	Other	Total	
United States:											
New England States:											
Connecticut	--	2,052	2,627	--	4,679	582	153	--	187	922	5,601
Maine	--	1,136	1,589	56	2,781	--	863	--	304	1,167	3,948
Massachusetts	789	5,122	4,774	1,077	11,762	2,287	1,063	--	1,878	5,228	16,990
New Hampshire	--	1,205	1,299	30	2,534	184	192	1	8	385	2,919
Rhode Island	--	773	1,116	--	1,889	123	--	--	--	123	2,012
Vermont	--	1,771	1,580	111	3,462	1,806	2,786	--	59	4,651	8,113
Total	789	12,059	12,985	1,274	27,107	4,982	5,057	1	2,436	12,476	39,583
Middle Atlantic States:											
New Jersey	887	9,091	24,254	5,208	39,440	3,525	2,852	2,611	80,691	89,679	129,119
New York	611	77,910	49,996	97,162	225,679	73,507	40,896	67,737	64,983	247,123	472,802
Pennsylvania [1]	3,926	108,330	249,043	214,564	575,863	284,984	389,786	437,163	1,895,096	3,007,029	3,582,892
Total	5,424	195,331	323,293	316,934	840,982	362,016	433,534	507,511	2,040,770	3,343,831	4,184,813
South Atlantic States: [2]											
Delaware	670	1,894	2,477	752	5,793	25	--	3,540	3	3,568	9,361
District of Columbia	--	2,197	1,773	169	4,139	238	121	--	--	359	4,498
Maryland	--	5,668	6,628	242	12,538	327	303	163	2,356	3,149	15,687
Virginia	--	430	433	--	863	--	1,030	--	1,764	2,794	3,657
West Virginia	--	--	79	7,562	7,641	127	2	2	27,600	27,731	35,372
Total	670	10,189	11,390	8,725	30,974	717	1,456	3,705	31,723	37,601	68,575
Lake States:											
Illinois	7,090	--	907	1,978	9,975	23,227	7,344	360	5,467	36,398	46,373
Indiana	--	--	640	(−18)	622	49	78	71	24,334	24,532	25,154
Michigan	2,492	57,155	8,815	7,600	76,062	1,590	177	14	2,402	4,183	80,245
Minnesota	--	--	5	5	10	6	1	4	13,889	13,900	13,910
Ohio	7,820	3,035	4,149	2,485	17,489	27,379	5,915	637	29,416	63,347	80,836
Wisconsin	--	1,130	1,155	54	2,339	3	33	3	2,569	2,608	4,947
Total	17,402	61,320	15,671	12,104	106,497	52,254	13,548	1,089	78,077	144,968	251,465

Other States	902	2,062	445	22,123	25,532	82,927	1,686	9,421	186,934	280,968	306,500
Total United States	25,187	280,961	363,784	361,160	1,031,092	502,896	455,281	521,727	2,339,940	3,819,844	4,850,936
Canada:											
Ontario	173	34,486	30,719	5,022	70,400	21,554	4,518	1,045	16,425	43,542	113,942
Quebec	--	715	6,023	3,164	9,902	26,398	33,942	148,923	208,975	418,238	428,140
Other Provinces	--	656	662	6	1,324	6	61	6	73	146	1,470
Total Canada	173	35,857	37,404	8,192	81,626	47,958	38,521	149,974	225,473	461,926	543,552
Other countries	93,480	203,318	165,804	18,613	481,215	4,290	1,609	2,484	62,143	70,526	551,741
Grand total	118,840	520,136	566,992	387,965	1,593,933	555,144	495,411	674,185	2,627,556	4,352,296	5,946,229

[1] Includes "Local sales."
[2] Shipments to other States in the South Atlantic area are included in "Other States."

Table 22.—Truck shipments of Pennsylvania anthracite in 1975, by month and State of destination [1]

(Thousand short tons)

Destination	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Percent of total trucked
Pennsylvania:														
Within region	161	127	145	102	92	82	95	102	96	89	80	117	1,288	35.8
Outside region	101	199	106	80	127	170	134	172	147	193	118	376	1,923	53.4
New York	38	27	26	11	24	33	24	25	29	27	18	18	300	8.3
New Jersey	8	3	5	(2)	4	6	4	3	5	6	5	7	56	1.6
Delaware	1	1	1	(2)	1	(2)	(2)	1	1	1	1	1	9	.2
Maryland	1	1	(2)	(2)	1	1	(2)	1	1	1	1	1	9	.3
Other States	4	(2)	(2)	(2)	(2)	1	1	2	1	1	1	5	16	.4
Total: [3] 1975	314	358	284	193	249	293	259	306	280	318	223	524	3,601	100.0
Total: 1974	375	295	282	312	271	325	295	326	344	362	394	336	3,917	100.0

[1] Compiled from reports of Pennsylvania Department of Mines and Mineral Industries; does not include dredge coal.
[2] Less than ½ unit.
[3] Data may not add to totals shown because of independent rounding.

Table 23.—Shipments of Pennsylvania anthracite, by destination [1]

(Thousand short tons)

Destination	1971	1972	1973	1974	1975
TRUCK SHIPMENTS					
Pennsylvania:					
Within region	1,880	1,584	1,511	1,410	1,288
Outside region	2,050	1,793	1,758	1,943	1,923
New York	373	441	380	416	300
New Jersey	126	89	77	77	56
Delaware	17	15	11	11	9
Maryland	29	23	26	30	9
District of Columbia	(2)	(2)	--	--	--
Other States	12	21	8	30	16
Total [3]	4,487	3,966	3,771	3,917	3,601
RAIL SHIPMENTS					
New England States	100	49	45	37	29
New York	532	281	299	187	106
New Jersey	113	85	55	34	55
Pennsylvania	819	830	856	679	586
Delaware	1	2	(2)	(2)	(2)
Maryland	24	2	1	23	1
District of Columbia	3	3	2	3	--
Virginia	7	3	8	15	3
Ohio	122	124	122	77	50
Indiana	54	42	43	34	25
Illinois	57	47	56	61	45
Wisconsin	8	10	8	6	3
Missouri	--	30	26	30	25
Minnesota	1	10	11	28	13
Iowa	--	31	36	47	42
Michigan	70	49	98	72	63
Other States	455	290	311	316	234
Total United States [3]	2,366	1,891	1,977	1,649	1,280
Canada	411	386	389	348	303
Other countries	572	374	384	327	394
Grand total [3]	[4] 3,349	[4] 2,651	2,750	2,324	1,977

[1] Compiled from reports of Pennsylvania Department of Mines and Mineral Industries; does not include dredge coal.
[2] Less than ½ unit.
[3] Data may not add to totals shown because of independent rounding.
[4] Corrected figure; erroneously reported in 1971 and 1972.

Table 24.—Consumption of Pennsylvania anthracite in the United States, by consumer category
(Thousand short tons)

Year	Residential and commercial heating [e]	Colliery fuel	Electric utilities [1]	Cement plants	Iron and steel industry		Other uses [e]
					Coke making	Sintering and pelletizing [2]	
1971	3,850	15	1,646	W	421	339	1,037
1972	2,960	11	1,584	W	474	283	603
1973	2,917	11	1,442	W	467	231	603
1974	2,577	12	1,498	W	444	367	550
1975	2,128	10	1,482	W	326	[3]237	925

[e] Estimate. W Withheld to avoid disclosing individual company confidential data; included in "Other uses."
[1] Federal Power Commission.
[2] Annual Statistical Report, American Iron and Steel Institute.
[3] Annual Statistical Report, U.S. Bureau of Mines.

Table 25.—U.S. exports of anthracite, by country and customs district

	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
COUNTRY				
Argentina	--	--	31	$4
Australia	27,347	$482	1,868	285
Brazil	1,459	121	1,071	171
Canada	481,345	9,772	543,552	20,905
Chile	4,195	124	373	33
China, People's Republic of	--	--	674	11
Colombia	3	1	57	10
Dominican Republic	12	1	10	1
Ecuador	194	19	568	97
Finland	60	4	--	--
France	165,966	3,700	39,303	1,425
India	4	1	2,215	147
Iran	905	67	--	--
Italy	18,470	583	11,357	391
Korea, Republic of	773	29	142	7
Mexico	10,317	412	12,128	722
Netherlands	11,341	366	16,362	717
Panama	649	62	31	3
Philippines	1,541	127	225	16
Surinam	414	35	344	59
Sweden	3,271	265	2,959	261
Trinidad and Tobago	--	--	212	18
Venezuela	4,212	231	5,758	499
Vietnam, South	1,595	142	--	--
Other	1,100	33	361	19
Total	735,173	16,577	639,601	25,801
CUSTOMS DISTRICT				
Baltimore	23,514	551	433	65
Buffalo	128,260	3,120	127,829	4,065
Detroit	7,871	191	22,577	967
El Paso	--	--	338	11
Galveston	23	1	674	11
Great Falls	--	--	359	38
Houston	197	7	--	--
Laredo	10,317	412	11,540	709
Miami	11	12	92	2
Mobile	152	17	272	48
New Orleans	6,280	394	2,957	501
New York City	3,519	244	1,011	58
Nogales	--	--	250	3
Ogdensburg	45,062	1,028	72,739	2,117
Pembina	1,697	83	30	2
Philadelphia	505,775	10,394	397,497	17,143
Portland, Maine	139	2	390	15
San Francisco	1,407	104	296	21
San Juan	--	--	212	18
Savannah	184	3	--	--
St. Albans	--	--	75	5
Seattle	765	14	30	2
Total	735,173	16,577	639,601	25,801

Table 26.—Anthracite:[1] World production, by country

(Thousand short tons)

Country[2]	1973	1974	1975[p]
Belgium	2,759	2,247	1,661
Bulgaria	141	129	110
China, People's Republic of[e]	22,000	22,000	22,000
France	7,816	6,586	5,556
Germany, West	7,455	8,139	7,852
Ireland	71	75	66
Japan	239	154	101
Korea, North[e]	33,000	[r] 34,000	35,000
Korea, Republic of	14,959	16,825	19,393
Morocco	623	633	719
Netherlands	2,016	883	--
Peru	11	[r] [e] 11	11
Portugal	301	254	243
Romania[e]	17	22	22
South Africa, Republic of	1,552	1,582	1,754
Spain	[r] 3,295	3,250	3,394
U.S.S.R	84,253	83,586	84,000
United Kingdom	3,697	2,793	[e] 2,700
United States (Pennsylvania)	6,830	6,617	6,203
Vietnam, North[e]	3,300	[r] 3,900	4,400
Total	[r] 194,435	193,686	195,195

[e] Estimate. [p] Preliminary. [r] Revised.

[1] An unspecified amount of semianthracite is included in figures for some countries.

[2] In addition to the countries listed, Canada, Colombia, New Zealand, and South Vietnam produce anthracite, but the level of production is not recorded and available information is inadequate to make reliable estimates; output in Colombia may total 100,000 tons annually, while output in New Zealand and South Vietnam is insignificant.

Table 27.—Production trends for Pennsylvania anthracite, 1890–1975

Year	Total production (short tons) [1]	Method of production (short tons)				Average productivity, tons per man-day		Quantity loaded mechanically underground (short tons)	Percentage of total loaded underground
		Deep mine	Strip	Culm	Dredge	Total	Strip		
1890	46,468,641	NA	NA	NA	NA	1.85	NA	NA	NA
1891	50,665,431	NA	NA	NA	NA	1.98	NA	NA	NA
1892	52,472,504	NA	NA	NA	NA	2.06	NA	NA	NA
1893	53,967,543	NA	NA	NA	NA	2.06	NA	NA	NA
1894	51,921,121	NA	NA	NA	NA	2.08	NA	NA	NA
1895	57,999,337	NA	NA	NA	NA	2.07	NA	NA	NA
1896	54,346,081	NA	NA	NA	NA	2.10	NA	NA	NA
1897	52,611,681	NA	NA	NA	NA	2.34	NA	NA	NA
1898	53,382,645	NA	NA	NA	NA	2.41	NA	NA	NA
1899	60,418,005	NA	NA	NA	NA	2.50	NA	NA	NA
1900	57,367,915	NA	NA	NA	NA	2.40	NA	NA	NA
1901	67,471,667	NA	NA	NA	NA	2.37	NA	NA	NA
1902	41,373,595	NA	NA	NA	NA	2.40	NA	NA	NA
1903	74,607,068	NA	NA	NA	NA	2.41	NA	NA	NA
1904	73,156,709	NA	NA	NA	NA	2.35	NA	NA	NA
1905	77,659,850	NA	NA	NA	NA	2.18	NA	NA	NA
1906	71,282,411	NA	NA	NA	NA	2.25	NA	NA	NA
1907	85,604,312	NA	NA	NA	NA	2.33	NA	NA	NA
1908	83,268,754	NA	NA	NA	NA	2.39	NA	NA	NA
1909	81,070,359	NA	NA	NA	107,788	2.31	NA	NA	NA
1910	84,485,236	NA	NA	NA	102,853	2.17	NA	NA	NA
1911	90,464,067	NA	NA	NA	106,005	2.13	NA	NA	NA
1912	84,361,598	NA	NA	NA	96,009	2.10	NA	NA	NA
1913	91,524,922	NA	NA	NA	150,064	2.02	NA	NA	NA
1914	90,821,507	NA	NA	NA	115,257	2.06	NA	NA	NA
1915	88,995,061	NA	1,121,603	NA	138,421	2.19	NA	NA	NA
1916	87,578,493	NA	1,987,800	NA	160,507	2.16	NA	NA	NA
1917	99,611,811	NA	2,301,588	NA	170,672	2.27	NA	NA	NA
1918	98,826,084	NA	2,360,183	NA	282,930	2.29	NA	NA	NA
1919	88,092,201	NA	2,006,879	NA	693,093	2.14	NA	NA	NA
1920	89,598,249	NA	2,054,441	NA	740,453	2.28	NA	NA	NA
1921	90,473,451	NA	2,027,790	NA	623,329	2.09	NA	NA	NA
1922	54,683,022	NA	949,745	NA	904,108	2.31	NA	NA	NA
1923	93,339,009	NA	2,263,098	NA	956,368	2.21	NA	NA	NA
1924	87,926,862	NA	1,865,677	NA	825,394	2.00	NA	NA	NA
1925	61,817,149	NA	1,578,478	NA	1,015,708	2.12	NA	NA	NA
1926	84,437,452	NA	2,401,356	NA	914,764	2.09	NA	NA	NA
1927	80,095,564	73,657,818	2,153,156	NA	971,817	2.15	NA	2,223,281	3.0
1928	75,348,069	69,724,862	2,422,924	NA	943,401	2.17	NA	2,351,074	3.4
1929	73,828,195	69,963,848	1,911,766	NA	716,944	2.16	NA	3,470,158	5.0
1930	69,384,837	64,926,094	2,536,288	NA	643,291	2.21	NA	4,467,750	6.9
1931	59,645,652	53,459,502	3,813,237	NA	458,750	2.37	NA	4,384,780	8.2
1932	49,855,221	43,834,160	3,980,973	NA	480,050	2.54	NA	5,433,340	12.4
1933	49,541,344	41,032,111	4,932,069	NA	538,924	2.60	NA	6,557,267	16.0

See footnotes at end of table.

Table 27.—Production trends for Pennsylvania anthracite, 1890–1975—Continued

Year	Total production (short tons)[1]	Method of production (short tons): Deep mine	Strip	Culm	Dredge	Average productivity, tons per man-day: Total	Strip	Quantity loaded mechanically underground (short tons)	Percentage of total loaded underground
1934	57,168,291	48,574,741	5,798,138	NA	652,180	2.53	NA	9,284,486	19.1
1935	52,158,783	43,782,876	5,187,072	2,702,468	590,467	2.68	NA	9,279,057	21.2
1936	54,579,535	44,726,506	6,203,267	3,193,972	546,684	2.79	NA	10,827,946	24.2
1937	51,856,433	42,566,351	5,696,018	2,722,599	760,474	2.77	NA	10,683,837	25.1
1938	46,099,027	38,142,297	5,095,341	2,340,444	571,024	2.79	NA	10,151,669	26.6
1939	51,487,377	42,571,548	5,486,479	2,583,814	703,860	3.02	NA	11,773,833	27.7
1940	51,484,640	41,516,837	6,352,700	2,783,038	942,944	3.02	NA	12,326,000	29.7
1941	56,368,267	43,877,264	7,316,574	3,656,866	1,517,563	3.04	NA	13,441,987	30.6
1942	60,327,729	45,236,699	9,070,933	4,735,064	1,285,033	2.95	NA	14,741,459	32.6
1943	60,643,620	42,735,798	8,989,387	7,583,698	1,334,737	2.78	NA	14,745,793	34.5
1944	63,701,363	41,775,416	10,953,030	9,600,180	1,372,737	2.79	NA	14,975,146	35.8
1945	54,933,909	34,885,699	10,056,325	8,786,659	1,205,226	2.79	NA	13,927,955	39.9
1946	60,506,873	38,084,457	12,858,903	8,431,092	1,132,394	2.84	NA	15,619,162	41.0
1947	57,190,009	36,963,112	12,603,545	6,403,646	1,219,706	2.78	NA	16,054,011	43.4
1948	57,139,948	37,175,291	13,352,874	5,623,779	988,004	2.81	NA	15,742,368	42.3
1949	42,701,724	27,030,650	10,376,808	4,429,144	865,122	2.87	NA	11,858,088	43.9
1950	44,076,703	28,155,895	11,833,934	3,467,310	619,564	2.83	NA	12,335,650	43.8
1951	42,669,997	26,342,239	11,135,990	4,630,200	561,568	2.97	NA	10,847,787	41.2
1952	40,582,558	24,748,283	10,696,705	4,765,516	372,054	3.06	NA	10,034,464	40.5
1953	30,949,152	17,893,489	8,606,482	4,011,000	438,181	3.28	NA	6,838,769	38.2
1954	29,083,477	16,852,408	7,939,680	3,565,482	725,907	4.02	NA	6,978,035	41.4
1955	26,204,554	14,498,758	7,703,907	3,213,046	788,843	3.96	NA	6,660,939	45.9
1956	28,900,220	15,054,904	8,354,230	4,774,799	716,287	4.25	NA	7,308,110	48.5
1957	25,338,321	12,616,053	7,543,157	4,521,410	657,701	4.18	NA	6,657,479	52.8
1958	21,171,142	10,698,835	6,877,761	2,902,753	691,793	4.36	7.94	5,332,043	49.8
1959	20,649,286	9,415,470	7,096,343	3,420,854	716,619	5.12	9.40	4,700,542	49.9
1960	18,817,441	7,695,978	7,112,288	3,297,012	712,163	5.60	10.51	4,044,392	52.6
1961	17,446,439	6,784,586	7,246,646	2,669,359	745,848	5.63	10.96	3,337,778	49.8
1962	16,893,646	6,672,922	6,822,207	2,671,466	727,051	5.92	11.01	3,065,364	45.9
1963	18,267,384	6,714,746	7,467,842	3,393,066	691,730	6.27	11.02	3,665,962	54.6
1964	17,184,251	5,888,826	7,177,188	3,412,989	705,248	6.11	10.76	3,455,034	58.7
1965	14,865,955	5,296,989	5,938,982	2,929,527	700,457	6.55	11.65	3,246,034	61.3
1966	12,941,264	4,088,144	5,253,408	2,938,095	661,617	6.87	NA	2,590,547	63.4
1967	12,256,063	3,258,000	4,740,187	3,627,000	631,660	7.21	NA	1,997,806	61.3
1968	11,460,833	2,450,000	4,696,163	3,709,000	605,920	7.62	NA	1,475,000	60.2
1969	10,472,916	2,106,000	4,578,732	3,253,000	535,369	7.45	10.06	1,326,598	63.0
1970	9,729,398	1,742,000	4,541,452	3,036,000	409,354	7.10	8.98	1,150,596	66.1
1971	8,727,325	1,286,666	4,478,350	2,572,700	389,609	6.30	8.34	669,961	52.1
1972	7,106,295	944,000	3,483,000	2,202,000	476,792	6.88	NA	593,997	62.9
1973	6,829,961	726,000	3,279,000	2,384,000	441,076	7.15	NA	421,000	58.0
1974	6,616,866	657,000	2,869,000	2,940,000	150,468	7.87	NA	307,000	46.8
1975	6,203,310	641,000	2,564,000	2,922,000	76,142	7.45	NA	299,000	46.6

NA Not available.
[1] Data may not add to totals shown because of independent rounding.

Sources: Minerals Yearbook (Fuels), Bureau of Mines, U.S. Department of the Interior; and Selected Annual Reports, Pennsylvania Department of Environmental Resources, Office of Mines and Land Protection.

Cobalt

By Scott F. Sibley [1]

Demand for cobalt declined significantly in 1975 in line with general industrial activity. However, consumption accelerated during the last quarter. Total reported consumption of cobalt in the United States in 1975 was 12.8 million pounds, the lowest since 1971 and 32% below that of 1974. The major decreases in consumption in order were superalloys, magnetic alloys, and cutting and wear-resistant materials. Government releases of cobalt from the strategic stockpile were a significant source of supply during 1975, with over 6.3 million pounds delivered to consumers.

Legislation and Government Programs.—The General Services Administration (GSA) continued to offer cobalt metal in various forms for sale during 1975. Sales were on an unrestricted-bid basis except that total sales of specification-grade material were limited to about 1 million pounds per month and 500,000 pounds per bidder per month. The stockpile objective for cobalt remained at 11,945,000 pounds in 1975. As of December 31, 1975, the total U.S. Government stockpile inventory was 47,649,355 pounds of cobalt. Government sales of cobalt for the year totaled 4,896,384 pounds, compared with 8,649,811 pounds sold in 1974. Deliveries of cobalt from Government stockpiles from current or prior year sales totaled 6,345,327 pounds.

Table 1.—Salient cobalt statistics
(Thousand pounds of contained cobalt)

	1971	1972	1973	1974	1975
United States:					
Consumption	12,500	14,130	18,741	18,861	12,787
Imports for consumption	10,912	13,915	r 19,238	r 16,122	6,608
Stocks, Dec. 31: Consumer	1,411	1,193	2,451	2,047	1,837
Price: Metal, per pound	\$2.20–\$2.45	\$2.45	\$2.45–\$3.10	\$3.10–\$3.75	\$3.75–\$4.00
World: Production, mine	54,598	r 54,752	r 64,856	r 71,582	72,564

r Revised.

DOMESTIC PRODUCTION

There was no domestic mine production of cobalt in 1975. However, Amax Inc. continued to refine cobalt at its refinery in Braithwaite, La. The production level rose to about 30% of capacity in October 1975 and was expected to reach 75% of capacity in 1976. This could result in a production of 900,000 pounds of cobalt for 1976. Nickel-cobalt and copper-cobalt matte was supplied to the plant from New Caledonia, Botswana, and the Republic of South Africa. Total cobalt production at the refinery in 1975 was 65,000 pounds.

An international consortium was formed to recover cobalt-bearing manganese nodules from the sea floor, raising to three the number of organizations with American interests active in ocean mining research and development. Participants in the venture were International Nickel Co. Inc. of both Canada and the United States; Deep Ocean Mining Co. of Japan; and a German group comprised of Metallgesellschaft AG; Preussag, AG; Rheinische Braunkohlenworke AG; and Saligitter AG.

[1] Physical scientist, Division of Ferrous Metals.

The Second United Nations International Law of the Sea Conference was held in Geneva, Switzerland, in the spring, and another conference to be held in New York City was scheduled for late March of 1976. Legal and other problems associated with ocean mining were not resolved at the Geneva meeting.

The Bureau of Mines undertook a feasibility study of a 5,000-ton-per-day plant to recover nickel and cobalt from laterite ore in northern California and southwestern Oregon. Using a new Bureau of Mines process (See Technology section), as much as 1.5 million pounds of cobalt could be produced per year.

The environmental debate over development of the Duluth Gabbro (Minnesota) copper-nickel-cobalt deposit continued during the year. Officials of International Nickel Co. Inc. stated their unwillingness to proceed with development until the pollution restrictions were clarified by the State. Amax Inc. was also interested in the deposit and was planning further development. However, no actual mining was expected before 1983.

CONSUMPTION AND USES

Consumption of cobalt in the United States in 1975 dropped significantly, but consumption trended upward during the last quarter of 1975 in line with general industrial activity. The 12.8 million pounds reported to be consumed was the lowest since 1971 and 32% below that of 1974. Of the cobalt consumed in the United States in 1975, 72% was as metal, 22% as salts and driers, 3% as oxide, and 3% as purchased scrap. Consumer stocks declined 10% from their 1974 yearend level.

Rare earth-cobalt magnets continued to dominate the news related to new products containing cobalt. In one technologic advance, announced by Kollmorgen Corp.'s Inland Motor Division of Hartford, Conn., cobalt-bearing permanent magnets were used in a new type of servo motor (direct current). Its benefits reportedly include considerable savings in copper and iron, and a reduction in the magnet's overall weight, with no decrease in motor performance.[2]

Th. Goldschmidt AG of Essen, West Germany, developed a patented process for the production of rare earth-cobalt alloy powders ("TEGOMAG" powders). The process reportedly eliminates several steps in production, thus cutting costs, and is based on a calciothermic reduction of oxidic starting materials.[3]

A new electric car, the Transformer 1, developed by Electric Propulsion Corporation of Troy, Mich., used lead-cobalt batteries that can be charged in several different ways. One method is to use a conventional slow charge with an onboard charger. Using an external fast charger, an 80% recharge takes only 45 minutes. For long-distance trips, the mobile charger can be towed to continuously recharge the batteries while driving. The batteries energize a 37 horsepower DC motor.[4]

The Stellite Division of Cabot Corp. announced the development of a Ni-Co-Cr-Fe alloy which reportedly offers excellent oxidation resistance, high temperature strength, and fatigue resistance in stressed applications at temperatures up to 2000 ° F. Use of lanthanum and tantalum in the alloy, designated Haynes Development Alloy 556, is reported to improve oxidation resistance. The alloy can be machined, forged, and cold-formed by conventional methods and is intended for use in gas turbines, heat treating trays and fixtures, industrial fans, incinerators, and pollution control equipment.[5]

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[2] Industry Week. Emerging Technologies. V. 184, No. 11, Mar. 17, 1975, p. 20.
[3] Metal Bulletin. New RE–Co Powder Process. No. 6049, Dec. 12, 1975, p. 25.
[4] Industry Week. Emerging Technologies. V. 186, No. 2, July 14, 1975, p. 26.
[5] Materials Engineering. New High Temperature Alloy Useful to 2,000° F. V. 82, No. 2, August 1975, p. 47.

Table 2.—Cobalt materials consumed by refiners or processors in the United States
(Thousand pounds of contained cobalt)

Form [1]	1971	1972	1973	1974	1975
Alloy, matte and concentrate	356	120	14	[2] 245	[2] 340
Metal	2,899	3,063	4,028	4,754	3,162
Hydrate	18	16	60	46	41
Other	9	16	26	153	110

[1] Total consumption is not shown because some metal and hydrate originated from alloy and concentrate, and a total would involve duplication.
[2] Cobalt contained in imported matte.

Table 3.—Cobalt products produced and shipped by refiners and processors in the United States
(Thousand pounds)

	1974				1975			
	Production		Shipments		Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content
Metal	--	--	--	--	65	65	NA	NA
Oxide	1,029	731	894	634	W	W	W	W
Hydrate	1,265	782	1,015	628	573	353	604	373
Salts [1]	8,556	2,070	8,328	1,973	7,625	1,749	7,515	1,726
Driers	12,443	1,053	12,238	1,034	9,120	793	8,851	772
Total	23,293	4,636	22,475	4,269	17,383	2,960	16,970	2,871

NA Not available. W Withheld to avoid disclosing individual company confidential data.
[1] Various salts combined to avoid disclosing individual company confidential data.

Table 4.—Cobalt consumed in the United States, by end use
(Thousand pounds of contained cobalt)

Use	1975
Steel:	
Carbon	--
Stainless and heat resisting	37
Full alloy	185
High-strength low-alloy	3
Electric	W
Tool	291
Cast irons	W
Superalloys	2,255
Alloys (excludes alloy steels and superalloys):	
Cutting and wear-resistant materials [1]	1,403
Welding and alloy hard-facing rods and materials	475
Magnetic alloys	2,033
Nonferrous alloys	695
Other alloys	395
Mill products made from metal powder	W
Chemical and ceramic uses:	
Pigments	129
Catalysts	1,112
Ground coat frit	84
Glass decolorizer	41
Other	212
Miscellaneous and unspecified	566
Total	9,916
Salts and driers: Lacquers, varnishes, paints, ink, pigments, enamels, glazes, feed, electroplating, etc	2,871
Grand total	12,787

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."
[1] Includes cemented and sintered carbides and cast carbide dies or parts.

Table 5.—Cobalt consumed in the United States, by form
(Thousand pounds of contained cobalt)

Form	1971	1972	1973	1974	1975
Metal	9,006	10,509	14,240	14,420	9,202
Oxide	625	733	668	536	372
Purchased scrap	125	197	264	270	342
Salts and driers	2,744	2,691	3,569	3,635	2,871
Total	12,500	14,130	18,741	18,861	12,787

PRICES

The producer price of $3.75 per pound for cobalt metal granules (shot) or broken cathodes in 551-pound (250-kilogram) drums was increased to $4.00 per pound f.o.b. New York or Chicago on January 23, 1975. The price remained unchanged for the rest of the year. A weighted average price for the year was $3.98 per pound of cobalt. Reportedly, the last price change reflected a realignment of the value of the U.S. dollar with respect to the Belgian franc and did not represent an increase in the world price of cobalt as expressed in Belgian francs.

Sales of cobalt metal by the Government on a "sealed-bid" basis ranged from $3.48 to $3.75 per pound of cobalt. All prices were f.o.b. carrier's conveyance at government storage locations.

FOREIGN TRADE

Exports of unwrought cobalt metal and alloys and of waste and scrap totaled 3,133,346 pounds, gross weight, having a value of $7,037,043, and went to 22 countries. West Germany and Japan received the greatest part, with 1,215,977 pounds ($2,715,825) and 622,960 pounds ($949,443), respectively. Exports of wrought cobalt metal and alloys, 1,103,941 pounds, gross weight, having a value of $7,843,843, went to 17 countries.

Zaire, Belgium-Luxembourg, Finland, Norway, and Canada were the top five sources of imports of cobalt to the United States in 1975. Of particular note was the first import of cobalt-bearing matte from Botswana, the French Pacific Islands, and the Republic of South Africa. The material was refined at the renovated copper-nickel-cobalt refinery of Amax Inc., located in Braithwaite, La. Total imports of cobalt dropped from 16.1 million pounds in 1974 to 6.6 million pounds in 1975.

Table 6.—U.S. imports for consumption of cobalt, by country
(Thousand pounds and thousand dollars)

Country	Metal				Oxide				Salts and compounds				Other forms			
	1974		1975		1974		1975		1974		1975		1974		1975	
	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value
Australia	1	2	10	14	--	--	(1)	1	--	--	--	--	--	--	--	--
Belgium-Luxembourg	4,180	15,665	1,362	7,727	1,472	4,401	232	773	(1)	(1)	(1)	1	--	--	--	--
Botswana	--	--	--	--	--	--	--	--	--	--	--	--	1,250	3,018	6,111	11,639
Canada	215	770	415	1,441	--	--	--	--	1	4	1	(1)	--	--	--	--
Finland	861	3,088	1,105	4,459	--	--	--	--	--	--	--	--	--	--	--	--
France	272	633	33	156	--	--	(1)	(1)	(1)	1	(1)	(1)	--	--	--	--
French Pacific Islands	--	--	--	--	--	--	--	--	--	--	--	--	14,838	14,440	16,334	20,116
Germany, West	55	99	36	158	36	109	1	5	1	6	(1)	4	--	--	--	--
Greece	5	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Japan	--	--	3	4	(1)	(1)	--	--	--	--	(1)	1	--	--	--	--
Mexico	6	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Netherlands	16	28	46	105	--	--	--	--	--	--	--	--	--	--	--	--
Norway	1,820	4,261	706	2,748	--	--	--	--	--	--	--	--	--	--	--	--
South Africa, Republic of	--	--	--	--	--	--	--	--	--	--	--	--	3,198	8,880	3,486	7,642
Sri Lanka	--	--	--	--	--	--	--	--	--	--	(1)	1	--	--	--	--
Switzerland	50	77	--	--	1	4	--	--	--	--	--	--	--	--	--	--
United Kingdom	228	376	88	161	--	--	(1)	(1)	(1)	1	40	66	--	--	--	--
Zaire	7,468	24,292	2,238	8,643	--	--	--	--	--	--	--	--	--	--	--	--
Zambia	114	354	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	14,791	49,661	6,092	25,611	1,509	4,514	233	779	2	12	41	73	19,286	26,338	25,931	39,397

[1] Less than ½ unit.

Table 7.—U.S. imports for consumption of cobalt, by class
(Thousand pounds and thousand dollars)

Class	1973	1974	1975
Metal: [1]			
Gross weight	18,398	14,791	6,092
Cobalt content [e]	18,398	14,791	6,092
Value	$53,772	$49,661	$25,611
Oxide:			
Gross weight	1,150	1,509	233
Cobalt content [e]	828	1,086	168
Value	$2,714	$4,514	$779
Salts and compounds:			
Gross weight	62	2	41
Cobalt content [e]	12	(2)	8
Value	$51	$12	$73
Other forms: [3]			
Gross weight	--	19,286	25,931
Cobalt content [e]	--	245	340
Value	--	$26,338	$39,397
Total:			
Gross weight	19,610	r 35,588	32,297
Cobalt content [e]	19,238	r 16,122	6,608

[e] Estimate. [r] Revised.
[1] Includes unwrought metal and waste and scrap.
[2] Less than ½ unit.
[3] Contained cobalt in copper-nickel and nickel matte.

WORLD REVIEW

Supplemented by U.S. Government stockpile releases, which constituted about 47% of U.S. supply in 1975, cobalt production in market economy countries was sufficient to meet world demand in 1975. Zaire led all countries in mine production of cobalt and accounted for 53% of the total world output. The most significant cobalt developments with regard to mining and refining capacity took place in Zaire, Australia, the Philippines, Japan, and the United States. The postponement or delay of projects around the world which would have increased capacity did not create a short supply situation.

Australia.—The Greenvale nickel-cobalt project, a joint venture of Freeport Queensland Nickel, Inc. (a subsidiary of Freeport Minerals Co., of New York) and Metals Exploration, Ltd., encountered serious mechanical difficulties in May. The plant at the Greenvale site in Queensland was designed to produce 2.75 million pounds of cobalt per year in the form of mixed sulfides, and the material was slated for shipment to a new refinery of Nippon Mining Co., Ltd. in Japan. However, in June Greenvale production of cobalt had reached only about 25% of anticipated capacity; by September nearly 80% of capacity had been reached.

The project was shutdown in October for 3 weeks to resolve some of the mechanical problems. According to company officials, production of nickel-cobalt sulfides more than tripled compared with the results of the third quarter of 1975, but new problems were revealed during the break period. Other difficulties which have plagued the venture were the cost of fuel oil, wages, and the relatively low nickel price. Despite these problems, production for the year was 60% of capacity, and deferments of shipments were not requested by customers.

During the year a crisis also developed over financing of the project. To alleviate a capital shortage, new funds totaling $20 million were made available by project lenders; initial interest payments were rescheduled to March 1977; and loan repayment would not be due until March 1979.

Canada.—A 10-week strike by employees of Falconbridge Nickel Mines Ltd., had virtually no effect on the cobalt market. About 5 weeks after the strike, which began on August 21, the Norwegian refinery for the nickel-copper-cobalt matte produced by Falconbridge was still being supplied with feed material. A 3-year pact between the company and the Mine, Mill and Smelter Workers, Local 598, composed of 3,500 union members, gave the workers an immediate 90 cents per hour raise, and 20 cents per hour annual raises were provided for in the succeeding years of the contract. Also included was a cost of living escalator.

In an unrelated development, Falconbridge agreed to sell its 72.8% interest in Kilembe Copper Cobalt, Ltd., of Uganda to Rengold Mines, Ltd., of Toronto, Canada, for $2.1 million.

Cuba.—Late in 1976 or early in 1977, Cuba reportedly was to begin construction of the first of three plants to process laterite ores containing about 0.1% cobalt from a new mine located at Punta Gorda. Each plant was to have a projected capacity of 33,000 tons of nickel-cobalt ore per year. The first mining and smelting complex was scheduled for completion in 1977, and the two other plants were expected to be in operation by 1980 and 1985. In addition, Cuba planned expenditures of $40 million to modernize its Moa Bay facility.

India.—Construction of the first Indian nickel-cobalt smelter, which had been scheduled to come onstream by late 1978, was deferred. The project was postponed because of a delay in commissioning a pilot plant for the processing of laterite ore in the Kansa area.

Indonesia.—The estimated cost of the Gag Island nickel-cobalt project in Irian Barat rose to approximately $700 million. Pacific Nickel Indonesia (PNI), comprised of Sherritt Gordon, Ltd. of Canada and two other companies, requested a direct loan from the Indonesian Government and cooperation from the Government in obtaining a World Bank loan for the venture. Capacity of the proposed mine was reported as 100 million pounds per year of nickel and 4 million pounds per year of cobalt in the form of mixed sulfides.

Japan.—The new nickel-cobalt refining plants of Nippon Mining Co., Ltd. and Sumitomo Metal Mining Co., Ltd. of Japan, with a combined capacity of 2,800 tons of cobalt and 5,500 tons of nickel per year, came onstream in July after several months delay in startup. A mixed sulfide feed material derived from processed laterite ore will be supplied to the facilities from Nonoc Island in the Philippines and Greenvale, Australia. Together, these facilities are to supply 50% of Japan's refined cobalt requirements. Until recently, Japan imported most of its cobalt needs, about 4,000 tons per year, from Zambia. The Australian feed material is a mixed sulfide containing 15% cobalt and 39% nickel and was delivered to Nippon Mining Co.'s Nitachi plant, where it underwent solvent extraction. The Philippine material was mined by Marinduque Mining & Industrial Corp. and delivered to the solvent extraction plant of Sumitomo in the Minama area on Shikoku Island.

Philippines.—Marinduque Mining & Industrial Corp. twice restructured its financing during the year for the new nickel-cobalt facility on Nonoc Island. At yearend, Marinduque reportedly was attempting to reschedule principal payments of $20,400,000 due to lenders in 1976 so as to be payable over a 3-year period in quarterly installments beginning in January 1978. The refinancing is the result of production delays caused by mechanical defects and redesign requirements, as well as high fuel prices and other operating costs. Officials stated that production at the refinery was expected to reach 50% of capacity by December 31, 1975, and 80% of capacity by mid-1976. In the third quarter of the year, production at the refinery averaged about 35% of design capacity.

Zaire.—La Générales des Carriéres et des Mines du Zaire (GÉCAMINES) reportedly obtained a major loan from three sources early in the year to help finance a $435 million expansion of its copper and cobalt mining and refining capacity. The Libyan Arab Foreign Bank (LAFB), European Investment (EIB), and the World Bank provided loans totaling $220 million, with the balance to be funded by GÉCAMINES. Plans for the expansion project at Kolwezi in Central Shaba Province included the development of two new open pit mines with ancillary treatment facilities. The latter consisted of a concentrator, smelter, and refinery of 100,000-ton capacity each. During the year, GÉCAMINES also contracted for a 100,000-ton-per-year copper flash smelter at Kolwezi as part of the aforementioned expansion. The smelter was to use the Outokumpu Oy flash smelting process, which incorporates improvements piloted in Zaire and Finland.

Part of the reason for the heightened activity was that 1975 was the first year of the Zaire Government's 5-year plan. Cobalt production under the plan was to have been raised to 44.1 million pounds in 1975, but because of the general decline in demand, production only reached 38.4

million pounds. Some progress was reported on the Dikuluwe open pit mines. Ore reserves at Dikuluwe and the neighboring Mashamba ore body were put at about 1.1 billion pounds. Ore from the new mines will be transported to the new Dima concentrator at Kolwezi. When the concentrator is completed, it will be able to handle up to 4.4 million tons of ore per year. A new rail link, which carried its first train in March of 1975, will carry ore from the open pit mines to the concentrator.

The Société Miniere de Tenke Fungurume (SMTF) copper-cobalt project in Zaire reportedly was suspended in January 1976 for an indefinite length of time. According to officials, the deferment resulted from a number of factors, one of which was exceptional increase in capital costs. The project was scheduled for completion early in 1978, with an eventual production of 14.3 million pounds of cobalt per year. Reserves of cobalt were estimated to be 505 million pounds. SMTF is a consortium composed of the following companies: Standard Oil Co. (Indiana), Charter Consolidated, Ltd., Anglo American Corp. and Rand Selection Corp., Ltd., French interests, Leon Tempelsman & Son, Inc., and the Zaire Government.

The main reasons for suspension of the project reportedly were (1) the relatively low copper price; (2) cost inflation (capital costs rose to an estimated $800 million); (3) doubts over power availability; (4) closure of the Benguela railway; and (5) the general uncertainty in central Africa generated by the civil war in Angola.

Zambia.—Transportation problems continued to impede shipments of copper and cobalt from Zambia. At one time during the year, cobalt was being shipped by air to European clients. This operation was made profitable by the relatively high price of cobalt on the world market and reduced air transport fees. The principal transportation problem in the country was lack of road transport. The Chinese-built Tanzam railway, which had lessened the strain on the road transport system, was not expected to be entirely completed before 1978. The outlets being used in 1975 were mainly Dar Es Salaam in Tanzania and Luanda in Angola until the latter part of the year.

Table 8.—Cobalt: World production, by country

(Short tons)

Country	Mine output, metal content [1]			Metal [2]		
	1973	1974	1975 [p]	1973	1974	1975 [p]
Australia	[r] 855	1,188	[e] 2,700	--	--	--
Botswana	[r] [e] 7	[r] [e] 36	[e] 89	--	[e] 9	[e] 9
Canada [3]	1,672	1,724	1,475	667	359	623
Cuba [e]	1,800	1,800	1,800	--	--	--
Finland	[e] 1,400	[e] 1,400	1,386	1,113	895	905
France [4]	--	--	--	[r] 920	976	[e] 1,000
Germany, West [4]	--	--	--	408	392	[e] 400
Japan	--	--	--	12	11	53
Morocco	1,567	1,932	2,162	--	--	--
New Caledonia	[e] 1,900	[e] 2,100	[e] 2,100	--	--	--
Norway	NA	NA	NA	[5] 1,005	[5] 1,365	[5] 852
Philippines	[e] 45	[r] [e] 45	[e] 130	--	--	117
U.S.S.R. [e] [6]	1,850	1,900	1,950	1,850	1,900	1,950
United States	--	--	--	--	--	33
Zaire	16,592	19,436	[e] 19,220	16,592	19,362	15,040
Zambia	[r] [e] 4,740	[r] [e] 4,230	[e] 3,270	[r] 2,937	2,622	[e] 2,026
Total	[r] 32,428	35,791	36,282	[r] 25,504	27,891	23,008

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] In addition to the countries listed, Bulgaria, Cyprus, East Germany, Greece, Poland, the Republic of South Africa, Spain, Sweden, and Uganda are known to produce ore (copper, nickel, and/or pyrite) that contain recoverable quantities of cobalt, but available information is inadequate to make reliable estimates of output levels. Other nations may also produce cobalt as a byproduct component of ores and concentrates of other metals.

[2] In addition to the countries listed, the United Kingdom recovers cobalt metal from intermediate metallurgical products produced in Canada, but data on output are inseparable from the total reported by Canadian producers. Czechoslovakia presumably recovers cobalt from materials imported from Cuba, but data are inadequate to estimate output. Belgium and Japan, both of which import substantial quantities of crude materials containing cobalt, have not recorded output in recent years but are producing metal and/or cobalt compounds. Poland also apparently processes cobalt-bearing copper ores, but no data on cobalt recovery are available.

[3] Actual output not reported. Data presented for mine output are total cobalt content of all products, including nickel oxide sinter shipped to the United Kingdom for further processing and nickel-copper matte shipped to Norway for further processing. Data presented for metal output are total cobalt content of all products less cobalt output recorded for Norway. Thus, the metal data include cobalt content of oxides and other compounds that are not produced as metal and total metal output in the United Kingdom as well as actual metal output in Canada itself.

[4] Domestic mine output, if any, is negligible.

[5] Produced entirely from nickel-cobalt matte from Canada; domestic mine output is recovered abroad.

[6] Insufficient data are available to permit separate estimates for mine and metal production.

TECHNOLOGY

Bureau of Mines researchers continued work on a low cost rare-earth cobalt permanent magnet. Using mischmetal-cobalt magnets with addition of an optimum quantity of selected elements, the researchers hope to approach the properties of currently available samarium-bearing magnets.

A new production process for rare earth-cobalt alloy powders developed and patented in West Germany by Th. Goldschmidt AG is based on the calciothermic reduction of oxide starting materials. Mixtures of oxides and metal powders are converted in the presence of calcium vapor into a fine-grained alloy powder and calcium oxide. The reaction product is then crushed; the calcium oxide is separated from the alloy by wet chemical methods; and the alloy powder is dried in vacuum. Reportedly, the process can be adapted to make alloys of any rare-earth mixture as well as alloys varying from the 1:5 stoichiometry of $SmCo_5$.

A range of polymer-bonded cobalt-rare earth permanent magnet materials reportedly now being produced uses simplified manufacturing techniques of plastic molding technology. The development of these new materials could signal a revolution in the use of miniature magnets. Advantages and properties of the magnet material include (1) the possibility of producing a wide variety of shapes; (2) good resistance to chipping; and (3) high maximum energy product leading to significant size reductions. Among the possible applications are miniaturized permanent magnet motors, phonograph pickups, and miniature transducers.[6]

[6] Work cited in footnote 3.

Through investigations, researchers at the University of Notre Dame and elsewhere were gaining greater insight into the phenomenon of magnetostriction, which is the change in dimension of a ferromagnetic body when a magnetic field is applied. The researchers reportedly were tabulating the properties of 15 rare-earth cobalt alloy magnets, some of which are more powerful than conventional Alnico types. From the data, engineers may be able to select the best magnetostrictive device for a given task. Potential applications for magnetostriction are testing and monitoring of materials in a working jet engine or in a hot nuclear reactor.[7]

A silicon-carbide composite material that could someday reduce cobalt consumption in its major application in superalloys for jet engines reportedly was successfully flight tested during the year. The composite ceramic material, made from silicon carbide-coated boron filaments, is being fabricated as jet engine fan blades. The leading edges of the finished blades are coated with nickel and cobalt for protection. According to one official involved in the testing, maximum use of the ceramic material could provide a 15% to 20% weight savings in jet engines.[8]

Two Japanese companies, Marubeni America Corporation and Mifuji Iron Works Co., have undertaken a research and development program to recover cobalt and other metals from spent catalysts used in oil refineries and petrochemical plants. A pilot plant with a capacity to process 528 pounds of spent catalysts per day was scheduled for completion in September 1976. Development of the necessary technology was expected to be completed by March of 1976. By the end of 1977, the companies plan to have a commercial facility completed with an annual capacity for processing 20,000 tons of various catalysts. Presently in Japan, spent catalysts from oil and petrochemical plants are buried underground or returned to suppliers.[9]

Bureau of Mines researchers released a report on a technique to recover nickel and cobalt from domestic laterites. The report states that recovery can be effected by selective reduction of laterites at 350° to 600°C with carbon monoxide in a solution of ammonium sulfate, ammonia, and oxygen; cobalt and nickel are then leached from the resulting product. Nickel is selectively recovered from the leach liquor by solvent extraction, after which it is stripped from the organic phase with dilute sulfuric acid, and finally it is reduced electrolytically.[10]

A process was patented whereby oxide and silicate nickel ores could be processed to recover copper, nickel, cobalt, and magnesium. In the process, several batches of ore are leached with sulfuric acid until the magnesium content of the leach liquor becomes excessive. Excess ore is added to precipitate iron, and then copper is selectively precipitated from the leach liquor. Magnesium is later removed from the cobalt-nickel bearing liquor as magnesium hydroxide.[11]

Early in the year, International Nickel Co. Inc. patented a process for the continuous recovery of nickel and cobalt from oxide ore. Ore is preheated to 850° to 1,100° C and mixed with calcium chloride or sodium chloride and coal or coke. The mixture is heated to 900° to 1,100° in a hydrogen atmosphere. Combustion gas flow from a burning fuel is minimized to produce metallized nickel-cobalt particles.[12]

Three patents were obtained by Deepsea Ventures, Inc. in 1975 for the extraction of cobalt and other valuable metals from manganese nodules.

In the first method, nodules are leached in an aqueous solution of sulfuric acid and sodium chloride and heated to vaporize the values as chlorides. The vapors are then converted to an aqueous solution from which insoluble iron oxide is removed. The low-iron aqueous solution is contacted with a liquid ion exchange resin and the separate strip solutions are subjected to electrolysis.[13]

By a second method, an aqueous solution of ground nodules is treated with ferric chloride to form metal chlorides in the solution along with solid ferric oxides.

[7] Industry Week. Emerging Technologies. V. 184, No. 11, Mar. 17, 1975, p. 18.

[8] Industrial Research. Aircraft-composite Blades Take to the Air. V. 17, No. 11, November 1975, p. 55.

[9] American Metal Market. Japanese Seek Way to Recover Used Oil Refinery Catalyzers. V. 8, No. 119, June 19, 1975, p. 6.

[10] Siemens, R. E., P. C. Good, and W. A. Stickney. Recovery of Nickel and Cobalt From Low-Grade Domestic Laterites. BuMines RI 8027, 14 pp.

[11] Garingarao, R. M., and M. A. Palad. Cyclic Acid Leaching of Nickel-Bearing Oxide and Silicate Ores With Subsequent Iron Removal From Leach Liquor. U.S. Pat. 3,880,981, Apr. 29, 1975.

[12] Bell, M. C. E., J. A. E. Bell, R. Sridhar, and H. F. Baber (assignors to International Nickel Co. Inc.). Concentration of Nickel Values in Oxidized Ores. U.S. Pat. 3,876,415, Apr. 8, 1975.

[13] Kane, W. S., and P. H. Cardwell (assignors to Deepsea Ventures, Inc.). Method of Ocean Floor Nodule Treatment and Electrolytic Recovery of Metals. U.S. Pat. 3,901,775, Aug. 26, 1975.

The ferric oxide is separated from the solution and treated with hydrogen chloride to regenerate ferric chloride for recycling, and the pregnant solution is subjected to solvent extraction procedures to recover metal values.[14]

In the third method, nickel and cobalt are recovered from a solution obtained by leaching nodules with hydrochloric acid. The leach liquor is adjusted to a pH value of 3 to 6 and contacted with an organic solution to selectively extract nickel and cobalt. The loaded extracting solution is stripped of nickel with an aqueous acid and the liquor is then stripped of cobalt at a hydrogen ion concentration of at least 6 normal.[15]

[14] Cardwell, P. H., W. S. Kane, and J. A. Olander (assignors to Deepsea Ventures, Inc.). Method for Separating Nickel from Cobalt. U.S. Pat. 3,903,235, Sept. 2, 1975.

[15] McCutcheon, H. L., W. S. Kane, and P. H. Cardwell (assignors to Deepsea Ventures, Inc.). Method for Obtaining Metal Values by the Halidation of a Base Manganiferous Ore With Ferric Chloride Pre-Treatment. U.S. Pat. 3,903,236. Sept. 2, 1975

Coke and Coal Chemicals

By Franklin D. Cooper [1]

Production of coal coke in the United States in 1975 was 7.1% less than in 1974, principally because of a 16.7% decrease in production of pig iron and ferroalloys in blast furnaces. Also contributing to the decrease were a 22.8% reduction in shipments of foundry coke and a 24.8% decrease in the tonnage of coke shipped to other industrial plants.

Production remained relatively constant throughout the year and averaged 4.77 million tons per month. The average daily output from all slot-type and beehive plants ranged from a low of 144,000 tons in September to a high of 174,000 tons in March. Average daily total output in 1975 averaged 157,000 tons.

During the year the demand for coke was less than production. Producers' stocks of oven coke at 5.00 million tons were 4.06 million tons greater at yearend than 1 year earlier.

Blast furnaces continued to use the major portion of the Nation's coke production, receiving 93.4% of the 53.15 million tons of coke distributed by producers. The consumption of coke per ton of hot metal produced at blast furnaces averaged 1,222 pounds, compared with 1,219 pounds in 1974.

The coke equivalent of fuels injected through blast furnace tuyeres amounted to 98 pounds of coke equivalent (at 13,000 British thermal units (Btu) per pound) per ton of hot metal, compared with 104 pounds in 1974.

Breeze production per ton of coal coked averaged 114.6 pounds because of reportedly extended coking times and the slightly reduced use of low-volatile coals in the mixtures carbonized. Breeze is unsuitable for almost all metallurgical applications because of its small size and high volatile and ash contents. The larger part of the breeze production was used by producers for sintering iron-bearing dust and ores. However, 36.6% of the output was sold for industrial uses other than as fuel for steam plants or in agglomerating plants. The tonnage of breeze sold was 15.5% less than in 1974 and brought an average of $32.21 per ton, up from $17.83 in 1974.

The average cost of all bituminous coals and anthracite carbonized in slot ovens increased $7.72 per short ton to $44.21 per short ton. This increase was reflected in the average value of coal per ton of coke, which increased $11.16 per short ton to $64.55 per ton. The largest price increases occurred in foundry coke sales. Foundry coke prices, which averaged $106.52 per ton, f.o.b. plant, were $27.60 per ton higher than in 1974.

The production of tars, ammonia, crude light oil, and coke-oven gas decreased because less coal was carbonized.

Foreign trade was notably reduced with coke exports at 1.27 million tons equal to 2.2% of domestic production. About 85% of the exported coke went to Canada, the Netherlands, West Germany, and Mexico. Coke imports were 48.6% less than in 1974, and exports were down 0.4%.

The total value of all coals carbonized was $3,645.7 million, and the total value of all carbonization products was $5,261.3 million. The combined value of coke and breeze, the principal products, accounted for 87.5% of the total value of all products.

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[1] Physical scientist, Division of Coal; statistical data furnished by Division of Fuel Data.

Table 1.—Salient coke statistics

	1971	1972	1973	1974	1975
United States:					
Production:					
Oven coke -- thousand short tons --	56,664	59,853	63,496	60,737	56,494
Beehive coke ---------- do ----	772	654	829	845	713
Total ---------- do ----	57,436	60,507	64,325	[1] 61,581	57,207
Exports ---------- do ----	1,509	1,232	1,395	1,278	1,273
Imports ---------- do ----	174	185	r 1,094	3,540	1,819
Producers' stocks, Dec. 31 --- do ----	3,510	2,941	1,184	935	5,001
Consumption, apparent ----- do ----	56,689	60,046	r 65,765	64,092	53,687
Value of coal-chemical materials used or sold ---------- thousands --	$260,171	$294,905	$355,667	$652,735	$653,958
Value of coke and breeze used or sold ---------- do ----	$1,848,781	$2,080,074	r $2,575,150	$4,609,209	$4,607,292
Total value of all products used or sold ---------- do ----	[1] $2,108,953	$2,374,979	$2,930,817	$5,261,944	$5,261,250
World production:					
Hard coke --- thousand short tons --	377,744	r 381,315	r 403,254	r 404,898	398,152
Gashouse and low-temperature coke ---------- do ----	24,183	r 21,671	r 19,516	r 20,009	19,285

r Revised.
[1] Data do not add to total shown because of independent rounding.

COKE AND BREEZE

DOMESTIC PRODUCTION

A 16.7% decrease in the production of pig iron and ferroalloys in 1975 largely accounted for a 13.3% decrease in the demand for blast furnace coke. Output of oven coke plus beehive coke averaged 4.77 million tons per month, with 4.31 million tons produced in September and 5.39 million tons in March. Daily production for the year averaged 157,000 tons, down 7.1% from the average daily output of 1974.

Forty-eight furnace plants produced 91.7% of the oven coke. These plants, owned by or financially affiliated with iron and steel companies, were operated mainly to produce coke for iron blast furnaces. The remaining oven coke was produced by 14 merchant plants, who sold blast furnace, foundry, and other grades of coke on the open market.

Coke was produced in 19 States in 1975. The relative amounts of coke produced in the various States have changed little in the past decade. Because coke is used principally as a fuel and reducing agent in blast furnaces, the coke industry is concentrated in the major steel-producing areas of the Eastern and North-Central States. The bulk of the 1975 output came from 14 States east of the Mississippi River. Six States west of the river produced 7.7% of the total production. Pennsylvania, the largest producer, accounted for 27.1% of the output, followed by Indiana and Ohio. These three States accounted for 58.6% of the national output.

An average of 1,367 pounds of breeze-free coke was produced for each ton of coal carbonized in the United States in 1975. The 1975 yield of coke, which averaged 68.4%, has remained nearly constant during the past decade.

The term "coke breeze" generally refers to a mixture of carbonized bony coal, slaty rock, and coke particles passing through a ½-inch-square screen. More than 28% of the 1975 breeze production was used as fuel in agglomerating plants. The remainder was used in steam plants and in the production of elemental phosphorus from phosphate rock. The amount of breeze sold has increased significantly in recent years; about 45.6% of the 1975 production was sold.

The breeze yield per ton of coal carbonized is influenced by oven operating practices, the types of coals used, and the degree of pulverization of coal mixtures carbonized. The lowest yield of 2.83% was attained in Pennsylvania, while Illinois had the highest yield at 8.13%. At 5.21%, the national yield has not varied significantly during the past decade.

Oven-coke plants averaged 104.2 pounds of breeze produced per ton of coal carbonized. The yields at beehive-coke plants were substantially higher than those at oven plants, but beehive breeze production was negligible because only a few plants had recovery facilities.

Based on information derived from a variety of sources, the current total capacity of U.S. slot-type coke plants is approximately 200,000 tons per day. At this time, there are 231 coke batteries in the United States consisting of 13,224 slot ovens, each of which averages approximately 5,500 tons per year of coke production and which collectively have a theoretical maximum annual capacity of 74.4 million tons based on 365 days per year, 18 hours coking time for furnace coke, and 30 hours for foundry coke. Industry considers the normal life span of a coke-oven battery as 25 to 30 years. About 10% of the current capacity is less than 5 years old. Trade journals report that about 9 million tons of productive capacity is under construction.

Construction work in progress in 1975 on new coke-oven batteries included the No. 1 battery at Bethlehem Steel Corp.'s Northhampton works; a 56-oven battery at Jones & Laughlin Steel Corp.'s Aliquippa works; a 13-foot high, 85-oven, 1,500-ton-per-day-capacity battery of ovens at Republic Steel Corp.'s Cleveland works; and two batteries at United States Steel Corp.'s Gary works, one of which was scheduled to start operation in 1976.

Rehabilitation underway in 1975 included work on one 45-oven battery of the International Harvester Co., Chicago, Ill.; on two 106-oven batteries at Jones & Laughlin Steel Corp.'s Aliquippa works; on one 79-oven and three 59-oven batteries at Jones & Laughlin Steel Corp.'s Pittsburgh works; on the "C" battery of National Steel Corp., Granite City, Ill.; and on two batteries at United States Steel Corp.'s Clairton works.

Salem Corp.'s subsidiary, the Wilputte Corp., received a $40 million contract from Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, for a turnkey coke plant. The contract included a Wilputte-designed battery consisting of 60, 5-meter high, underjet, regenerative, low-differential coke ovens suitable for carbonizing mixtures of high- and low-volatile coals. The contract contained provisions for air pollution control devices and additional measures for the possible future installation of a Coaltek system. Completion of the contract was scheduled for the last quarter of 1977. Wilputte also received a contract in late June 1975 to build a coke plant for Republic Steel Corp. at Gadsden, Ala. Reportedly, the new battery of 85 coke ovens plus coal- and coke-handling equipment and certain coal chemical facilities would cost $75 million to $80 million.

Arthur G. McKee & Co., Cleveland, Ohio, in a joint venture with Dr. C. Otto and Comp. GmbH of Bochum, West Germany, received an order from Youngstown Sheet & Tube Co., a division of Lykes-Youngstown Corp., for a multimillion-dollar coke-oven plant and ancillary facilities to be built at the company's Indiana Harbor works in East Chicago, Ind. The turnkey project will include a coke battery of 85 large-capacity Otto ovens designed for a maximum coal throughput of 4,900 short tons per day, a 2.65-million-standard cubic feet per hour coke-oven gas purification plant, equipment for gas cooling and tar separation, recovery equipment for ammonia, benzol, and naphthalene, gas exhausters, and extensive facilities for the preparation and handling of coal and coke.

Armco Steel Corp.'s two new coke batteries, at Middletown, Ohio, each comprising 57 ovens (coal capacity, 32 tons), were scheduled for startup in mid-1976. Total bricklaying effort was about 41% complete as of July 1975. The two batteries and related facilities will produce 112,750 tons per month of blast furnace coke at a coking rate of 1.05 inch per hour from 165,000 tons of mixed high- and low-volatile coals. In addition to the 56 million cubic feet per day of coke-oven gas produced, other byproducts will include 44,000 gallons of tar, 36 tons of sulfuric acid, 13 tons of anhydrous ammonia, 12,000 gallons of benzene, 1,700 gallons of toluene, and 275 gallons of xylenes.

The Koppers Co. was constructing a 79-oven battery for the Wheeling-Pittsburg Steel Corp. at Follansbee, W. Va. About 20,000 tons of refractories, roughly equivalent to 6.5 million 9-inch brick, will be required to construct the 20-foot-high ovens. Related pollution control equipment will include a hooded coke guide connected to a fume-collecting main and scrubber, a screw-type feed system on larry cars, smoke-collecting hoods on leveler bars, a mechanical door and jam-cleaning device, and a double collecting main on the coke battery.

The East Chicago Department of Air Quality Control in early May 1975 granted Inland Steel Co. permission to operate its old "B" coke battery for another year, until the new "C" battery could be partially redesigned and improved. Inland Steel Co. spokesmen reported that substantial problems in both design and operation of its new smokeless coke battery had limited the "C" battery to about 60% of its planned coke production. Koppers Co., builder of the 56-oven "C" battery that was put into operation in the summer of 1974, had a crew at the site attempting to solve the problems.

Construction started in May 1975 on a 7,000-ton-per-day blast furnace and a "smokeless" 20-foot-high, 69-oven coke battery rated at 3,000 tons of coal per day at the Indiana Harbor works of Inland Steel Co.

CONSUMPTION AND SALES

Apparent consumption of coke in the United States totaled 53.69 million tons. This quantity (domestic production plus imports, minus exports and changes in stocks) was 10.40 million tons less than consumed in 1974. The decrease was attributed to a significantly smaller demand for blast furnace coke, caused by a 16-million-ton decrease in blast furnace pig iron and ferroalloy production.

The amount of breeze-free coke consumed by blast furnaces in producing 1 ton of hot metal increased from 1,219 pounds in 1974 to 1,222 pounds in 1975. In 1956, 1,720 pounds of coke were consumed per ton of hot metal produced by blast furnaces. Current consumption, about 500 pounds less than 2 decades ago, decreased as a result of the use of increased quantities of iron concentrates, oxygen, and supplemental fuels.

Although a variety of operating practices affect blast furnace coke rates, the 4-pound increase in the coke rate was accompanied by a 6-pound coke-equivalent decrease of supplemental fuels, excluding coal, injected through blast furnace tuyeres per ton of hot metal produced. The supplemental fuels were principally fuel oil, coal tar and pitch, natural gas, and coke-oven gas. Although the units of measurement differ, and the quantity of each fuel used varies, the total calorific value of all supplemental fuels consumed in blast furnaces in 1975 was equivalent to 3.9 million tons of coke. Oxygen consumption in blast furnaces equaled 25,923 million cubic feet, 0.4% more than in 1974. The use of oxygen reduces the blast furnace coke requirement by making available more sensible heat during the reduction of iron ore to pig iron.

Of the 53.15 million tons of oven and beehive coke distributed for all purposes in 1975, 49.62 million tons, including 1.27 million tons exported, went to blast furnaces; 2.61 million tons went to foundries; 0.92 million tons went to other industrial purposes. Producing companies produced 46.23 million tons of blast furnace coke for use in their own blast furnaces. Merchant plants produced 2.68 million tons of blast furnace coke that was sold to blast furnace plants.

Merchant plants produced 4.72 million tons of coke, 90.9% of which was sold on the open market. Principal markets were blast furnaces not associated with integrated coke-producing facilities, independent gray-iron foundries, nonferrous smelters, and chemical plants. Some of the merchant coke was used by its producers, principally in chemical plants and affiliated foundries. Essentially all of the coke distributed by beehive plants was sold for blast furnace use.

All States except Alaska, Delaware, Hawaii, Nevada, New Hampshire, South Dakota, and Vermont received shipments of coke or breeze in 1975. Alabama, Illinois, Indiana, Maryland, Michigan, New York, Ohio, Pennsylvania, and West Virginia, which were the major iron- and steel-producing States, received 88.8% of the total coke and 81.8% of the total breeze distributed.

The bulk of the distributed coke was blast furnace coke that was consumed within the producing State, since most blast furnaces were integrated with coke ovens. A few companies shipped coke to affiliated blast furnaces in other States.

About 5.0% of the breeze-free coke distributed was shipped to foundries. The chief consumers of foundry coke were the automotive, farm-machinery, machine-tool, heavy-machinery, railroad, and electrical equipment industries. Most of these industries were located in the Eastern and Midwestern States. The combined receipts of Alabama, Illinois, Indiana, Michigan, New Jersey, New York, Ohio, Pennsylvania, and Wisconsin, accounted for 74.8% of the foundry coke shipments. Foundry coke was shipped to 38 States.

Other industrial coke was used in 34 States for miscellaneous applications. The principal consumers were nonferrous smelters, and plants manufacturing sugar, mineral wool, alkalis, calcium carbide, and elemental phosphorus. Alabama, Missouri, Ohio, Pennsylvania and Texas received 49.8% of the shipments of other industrial coke.

STOCKS

Yearend stocks of slot-oven coke were 434% more than at yearend 1974 as the quantity of coke in stock increased by 4.06 million tons during 1975. Oven-coke plants ended the year with stocks equal to 34 days' production at the December 1975 rate. Normally, beehive plants do not stock coke.

The bulk of the stock, 94.4%, was at furnace plants, which roughly had a 33-day supply compared with a 21-day supply at merchant plants.

Because steel producers operating coke-oven batteries also produce gas for their mills, coke stocks increased awaiting an anticipated turnaround in steel demand.

Stocks of coke breeze at producers' plants increased 17.8% during 1975. Approximately 78.5% of the breeze in stocks was at furnace plants.

Despite more than adequate inventories, an upturn in world coke trade and price was foreseen because of the Government's mandating further coke-oven shutdowns in the United States. As a hedge against this possibility, the prediction was that the U.S. buyers would augment coke inventories by foreign purchases.

VALUE AND PRICE

The average value of receipts of all grades of oven coke reached $87.64, up $21.90 per ton, and beehive coke averaged $65.17, up $21.15 per ton. The 1975 average values represented increases of 33.3% for oven coke and 48.1% for beehive coke.

For oven coke, an increase of 35.0% raised the average price of foundry coke sales to $106.52 per ton; commercial sales to blast furnaces increased an average of 38.2% to $73.67 per ton. Oven coke used for other industrial purposes increased 29.8% in price to $77.02 per ton.

The differential between the average price of blast furnace and foundry oven coke is attributed to the special specifications for foundry coke that make it a more costly product having superior properties, resulting from long coking times at lower temperatures of coal mixtures containing up to 50 weight-percent low-volatile coal and occasionally petroleum coke and anthracite. The difference in the average values of oven and beehive cokes is partially due to the additional transportation costs of coal delivered to oven-coke plants and the substantial investment and maintenance costs of slot-type ovens.

The average price of foundry coke in the United States remained constant throughout much of 1975, with none of the six Bureau of Labor Statistics' sample cities showing any deviation for the final 4 months of the year. Prices in Indianapolis and Birmingham remained unchanged for the entire 12 months. In August, producers of foundry coke in Milwaukee, Wis., and Painesville, Ohio, dropped the price from $115.00 to $112.50 per short ton; Neville Island increased the price from $110 to $117 per short ton.

The price of domestic blast furnace coke remained firm in the range of $71.00 to $74.50 per short ton delivered.

FOREIGN TRADE

Foreign trade in coke was comparatively slower than in 1974. Exports at 1,272,906 short tons, 4,775 tons less than in 1974, amounted to 2.2% of total production. Approximately 84.7% of the total coke exported to more than 21 countries went to Canada, Mexico, the Netherlands, and West Germany at an average price of $55.85 per short ton. Exports from Buffalo, N.Y., Detroit, Mich., Norfolk, Va., and Philadelphia, Pa., totaled 943,542 tons at an average price of $53.49 per ton. Total exports averaged $58.71 per ton, or $24.62 per ton more than in 1974. Canada received 680,595 tons, or 53.5% of the total exports. Exports to Canada averaged $56.46 per ton.

Imports of coke totaled 1,818,981 short tons and averaged $86.03 per ton, compared with 3,540,326 tons imported in 1974 at $54.56 per ton.

Canada, the Netherlands, the Republic of South Africa, and West Germany together shipped 1,695,166 tons at $86.10 per ton to the United States. West Germany shipped 1,387,755 tons, averaging $88.71 per ton.

Baltimore, Md., Detroit, Mich., New Orleans, La., and Philadelphia, Pa., were the major ports of entry for 1,451,068 tons having an average price of $85.55 per ton.

COKING COALS

QUANTITY AND VALUE OF COAL CARBONIZED

A total of 83.3 million tons of bituminous coal was carbonized at high temperatures for the production of coke in slot-type and beehive ovens. This quantity, equaling 12.8% of the 1975 U.S. bituminous coal production, was the second largest coal market. In addition to bituminous coal, 326,000 tons, or approximately 5.3% of the U.S. anthracite production, was used in the coal blends carbonized. Anthracite was used principally in the production of foundry coke to achieve greater size and density, desirable properties in the operation of foundry cupolas.

The average delivered value of all coal and anthracite carbonized by oven-coke plants was $44.21 per ton. The average value of coal carbonized by beehive-coke plants cannot be published because of individual company confidentiality. Transportation costs account for the high value of the coal consumed by oven-coke plants in some States. Such costs often exceed the value of the coal at the mine.

The average value per ton of coal carbonized at oven-coke plants was 21.2% greater than in 1974. Coals delivered to all consuming States had increases in average value per ton ranging up to 34.1%. The highest coal price was recorded for Maryland and New York, where the value of coal carbonized averaged $57.27 per ton.

An overall average of 1.46 tons of coal, valued at $64.55, was required for each ton of oven coke produced. Beehive ovens required an average of 1.58 tons of coal per ton of coke output.

By early June 1975, several coal companies began slowing the production of "marginal quality" metallurgical coal. Normally, steel plants would not use such coal for coke production. However, some coals of this type were used during the period of high steel production in 1974 in the effort to increase blast furnace coke inventories.

Consolidation Coal Co. shortened work schedules at its metallurgical coal mines to 5 days a week from 6 days as slumping steel demand began affecting the coal industry. Bethlehem Steel Corp. shut down its Mine No. 45 in Jeffrey, Boone County, W. Va. This mine had been producing about 100,000 tons of metallurgical coal annually.

United States Steel Corp. planned to boost metallurgical coal production from its mines over the next several years, partly by opening new mines. The 1975 output was targeted to reach 18.5 million tons, up 12.8% from the 1974 actual output of 16.4 million tons. However, unauthorized work stoppages in the third quarter significantly decreased the estimate for the second half of 1975.

New United States Steel Corp. mines that eventually will produce much of the firm's coal are the Dilworth mine in southwestern Pennsylvania, the Oak Grove mine near Hueytown, Ala., the No. 37 mine in the Lynch district of Kentucky, and areas having less favorable mining conditions in the Robena mines complex in southwestern Pennsylvania and in the No. 10 mine at Gary, W. Va.

BLENDING

It is difficult to define a "good coking coal." Gradually the use of the word "good" is being replaced by "satisfactory." Satisfactory means that a coal or blend of coals produces a coke which, in turn, permits a blast furnace practice fully competitive in quality, efficiency, and cost. It is only rarely that a single coal is available for making a satisfactory coke; blending of two or more coals of different properties is the rule at a majority of coke plants. While a simple two-coal blend of high- and low-volatile coals is most common, there are cases in which the use of a third coal or other blending material is advantageous. Coal tar pitch, petroleum coke, coke breeze, and other carbonaceous materials have been tried and in some cases have been used commercially with success.

The terms "low-", "medium-", and "high-volatile coking coals" do not designate sharply defined classes. These terms are used by slot-oven operators in a relative sense, and the exact meanings intended by the individual operator may vary somewhat with the behavior of the coals with which he is most acquainted, or which are available for his plant.

The term "low-volatile coal" is used in this discussion to designate coals of 14% to 22% volatile matter, such as the Pocahontas and New River, W. Va., and Somerset County, Pa., type. For byproduct oven use, such coals are mixed with high-volatile coking coals in any proportion up to 60% or more (but usually from 10% to 30%) in order to increase the size and strength of the coke. This practice increases the coke yield and decreases the byproduct yields. Most slot-oven operators prefer low-volatile coals having a volatile matter content of about 16% to 18% (dry basis), although a considerable quantity of coal that does not come within this range is used. Low-volatile coals are not charged in an unmixed condition into slot ovens because they expand when coked.

The Bureau defines medium-volatile coking coals as those having 22% to 31% volatile matter, dry basis. Such coals have certain coking characteristics that differentiate them from coals having distinctly higher or lower volatile-matter content. Medium-volatile coals, when coked without admixture, nearly always produce large blocky cokes having highly desirable general physical characteristics. Many medium-volatile coals, particularly those having less than 24% to 25% volatile matter, are practically nonshrinking, or even slightly expanding under many operating conditions, in which cases the coke would be difficult or impossible to push from the slot oven.

The largest portion of the tonnage of all coals charged into slot ovens exceeds 31% volatile matter, dry basis, and is designated high-volatile coal by the Bureau. High-volatile coking coal is produced from many seams in many States. Because high-volatile coals when carbonized alone produce lower yields of weaker and smaller sized coke, many plants producing blast furnace coke add low- or medium-volatile coals to high-volatile coals to the extent of 10% to 30% of the weight of coal mixtures charged into the slot-type ovens. The use of anthracite imparts increased size and density, and the use of tar pitch in the coal mix increases the coke strength.

Blending also permits the use of some high-sulfur-content coals in admixture with low-sulfur coals so that the coke has an acceptable sulfur content.

The overall percentages of high-, medium-, and low-volatile coals in the mixtures carbonized have varied little in the past decade, although there are wide variations in the proportions used at individual plants. Coke plants in West Virginia and the Western States used the largest percentages of high-volatile coals in their blends, but plants in Minnesota and Wisconsin used the largest percentages of low-volatile coals. Compared with furnace plants, some merchant plants used approximately 50% of low-volatile coals in mixtures carbonized at lower temperatures during a longer coking time to produce foundry coke.

The types of coals used in each plant are determined by the availability of the desired coal, the moisture content, the ash-fusion temperature, the volatile matter content, the expansive properties, the delivered cost, the storage characteristics, the free-swelling index, and the physical and chemical properties of the coke product.

SOURCES OF COAL

Of the 26 States that produced bituminous coal in 1975, the 13 States that shipped coal to coke plants supplied 84.7 million tons of coal for coking. West Germany and Canada exported a total of 136,000 tons of coal for use in U.S. coke plants.

Of the coals received by oven-coke plants, 76.1% was produced in West Virginia, east Kentucky, and Pennsylvania. West Virginia shipments comprised low-volatile coals mainly from McDowell, Raleigh, and Wyoming Counties and medium-volatile coals mainly from McDowell and Raleigh Counties. Pennsylvania supplied high-volatile coals mainly from Allegheny, Greene, Washington and Westmoreland Counties and low-volatile coals mainly from Cambria and Somerset Counties. Pennsylvania and West Virginia coals were widely distributed and used in many of the coke-producing States. East Kentucky supplied 14.3% of the shipments to coke plants, all of which comprised high-volatile coals produced mainly in Floyd, Harlan, Letcher, and Pike Counties.

Illinois produced high-volatile coking coals, principally in Franklin and Jefferson Counties; other States with substantial production were Alabama, Colorado, Utah, and Virginia. Most of the coal produced in these States was used within the State. Colorado, New Mexico, and Utah, however, supplied most of the coals that were carbonized in California.

CAPTIVE COAL

About 53.6% of the coal received by all slot-oven plants was produced by company-owned or affiliated mines. Ordinarily, this captive coal does not enter commercial channels. In 1975, 56.5% of the coal received by furnace-coke plants was captive. Some merchant plants also owned coal mines, but only 18.5% of the coal received was captive production.

STOCKS

Stocks of bituminous coal at slot-oven plants ranged from 7.00 million tons to 10.01 million tons, equal respectively to 31 and 44 days' consumption at the yearly daily average of 225,000 tons. Bituminous coal stocks reached their highest yearly level during June, when month-end quantities totaled 10.01 million tons. The lowest level, 7.00 million tons, was reported at the end of September.

Bituminous coal stocks at the end of 1975 were 8.67 million tons, compared with 6.04 million tons when the year began. The 8.67 million tons in stock at all slot-oven plants at yearend was equal to a 39-day supply at the December 1975 rate of consumption.

Stocks of anthracite at yearend totaled 126,000 tons, equal to a 141-day supply at the 1975 average rate of consumption.

COAL CHEMICALS

The term "coal chemicals" refers to the refined materials recovered from crude liquids obtained from the gases and vapors released during coal carbonization. Three materials—ammonia, tar, and light oil—are normally recovered at slot-oven plants using condensation and absorption processes. The remaining noncondensible material, which is rich in hydrogen and methane, is called coke-oven gas. Except for ammonia, which is recovered as an aqueous solution or converted to ammonium sulfate or phosphate and sold as produced, the materials are in most instances further processed to yield a number of primary organic chemicals or chemical mixtures, the most important of which are benzene, toluene, xylenes, solvent naphtha, crude chemical oil (better known as carbolic oil), and pitch. Although many slot-oven plants in the United States are equipped to process tar and crude light oil, the extent to which such equipment is utilized depends upon economic conditions and tonnage of coal carbonized because yields of various chemicals are low.

Yields of chemicals vary with the kinds of coals carbonized, carbonizing temperatures, and operating techniques and equipment, but about 315 pounds of coke-oven gas, 90 pounds of tar, 20 pounds of crude light oil, and 5 pounds of ammonia can be recovered for each short ton of coal carbonized. In standard units of measure, these quantities amount to about 10,500 standard cubic feet of coke oven gas, 10 gallons of tar, and 3 gallons of crude light oil. Ammonia expressed as ammonium sulfate equivalent was recovered at an average rate of 17 pounds per ton of coal carbonized in those 51 plants employing recovery processes.

In terms of calorific value the products, excluding coke, recovered at oven-coke plants in 1975 totaled 602.3 trillion-Btu. This quantity was roughly equivalent to 30% of the heating value of the coal carbonized.

COKE-OVEN AMMONIA

Coal carbonized at high temperatures releases nitrogen and hydrogen, portions of which combine to produce ammonia. Ammonia must be removed from coke-oven gas to reduce the subsequent formation of corrosive compounds with oxygen, hydrogen sulfide, and hydrogen cyanide. Coke-plant operators normally recover ammonia as an aqueous solution or as ammonium sulfate or phosphate. However, 11 plants did not recover ammonia as a salable product in 1975.

Production of ammonia decreased 10.8%, although the number of recovery plants increased by five. The average value per ton of both ammonia liquor and ammonium sulfate increased, although the total value of sales decreased 11.9%. Ammonia products sold in 1975 represented 5.8% of the total value of all coal-chemical sales.

Wilputte Corp. announced in May that it had been awarded a contract to furnish necessary engineering services to prepare design and detail drawings for two ammonia stills and auxiliaries to be installed at the Sparrows Point, Md., coke plant of Bethlehem Steel Corp. The installation of these units will be part of the system being installed by Bethlehem for controlling the discharge of effluents from the coke plant. The facility will be erected by Bethlehem Steel Corp. and was expected to be operational by mid-1976.

COKE-OVEN GAS

The fixed gases resulting from the carbonization of coal have a gross heating value ranging from 520 to 600 Btu per standard cubic foot, and are principally used for heating coke ovens and steel- and allied-plant furnaces. Small volumes were sold for distribution through city mains and for minor industrial uses. Gas yields vary among plants, but the average quantity produced for each ton of coal carbonized in all slot ovens was 10,860 cubic feet, compared with the average yield of 10,890 cubic feet for 1974. The total gas production decreased 7.4% because 7.2% less tonnage of coal was carbonized in 1975.

About 39.6% of the coke-oven gas produced was used for heating ovens. Most of the remainder of the production was used by coke producers to fuel boilers or transferred to steel or allied plants to heat open-hearth and other metallurgical furnaces. A small part of the gas produced was flared in situations where production exceeded demand.

Although coke-oven gas was the principal fuel used to heat coke ovens in 1975, some ovens were heated by a mixture of coke-oven and blast furnace gas, or a mixture of blast furnace and natural gas. A total of 393.7 billion cubic feet of coke-oven gas equivalent was so consumed, of which about 90.0% was coke-oven gas.

Surplus coke-oven gas used and sold in 1975 was valued at $29.27 million, a 2.1% decrease from the 1974 value. No value was reported by producers for the coke-oven gas used to heat their ovens, but by applying the average value of $0.555 per thousand cubic feet reported for surplus gas to the gas used for underfiring, the total value of all coke oven gas used and sold in 1975 would be $296.8 million.

The so-called Sulfiban process developed jointly by Bethlehem Steel Corp. and B S & B Process Systems of Houston, Tex., was being installed at the corporation's Bethlehem, Pa., works to remove H_2S from coke-oven gas. The process, which reduces ethanolamine consumption, requires no catalyst or specialized equipment. Instead, ammonia injected into the sour coke-oven gas reacts with thiocyanates that form in the absorption fluid and which inhibit the absorption of sulfurous components. Urea formed in the reaction between thiocyanates and ammonia decomposes in the heated stripper reboiler, where rich ethanolamine solution is freed of H_2S before being recycled as lean absorption fluid. Some of the ammonia, which is also liberated, is recovered in a condenser and recycled to the lean ethanolamine solution going to the absorber.

The importance of the purification of coke-oven gas was clarified.[2]

Massey and Dunlap presented operating details and installed capital and net amortization and operating costs for four coke oven gas desulfurization processes—the Koppers two-stage vacuum carbonate process, the Dravo-Firma Carl Still process, Sulfiban process, and the Stretford process with effluent treatment.[3]

Singleton and Batterton offered operating data on a pilot plant used to demon-

[2] Massey, M. J., F. C. McMichael, and R. W. Dunlap. Influence of Coke-Oven Gas Composition on Distribution Line Fouling and Corrosion. Presented at Annual Joint Meeting of the Eastern States and Western States Blast-Furnace and Coke Plant Associations, Pittsburgh, Pa., Oct. 24, 1975.

[3] Massey, M. J., and R. W. Dunlap. Assessment of Technologies for the Desulfurization of Coke Oven Gas. AIME Ironmaking Proc., v. 34, 1975, pp. 583–603.

strate the Sulfiban process employing aqueous monoethanolamine as an absorbent that is thermally regenerated.[4]

An inventory of North American coke oven gas desulfurization plants, presumably as of mid-1975, follows:

Company	Location	Gas production	Process
Plants in operation:			
Bethlehem Steel Corp	Burns Harbor, Ind	120	Vacuum Carbonate/Claus.
	Lackawanna, N.Y	50	Do.
	Sparrows Point, Md	100	Vacuum Carbonate.
Dominion Foundry & Steel Ltd. (DOFASCO).	Hamilton, Ontario	42	Stretford.
Donner Hanna Coke Corp	Buffalo, N.Y	30	Vacuum Carbonate.
Inland Steel Co	Indiana Harbor, Ind	50	Vacuum Carbonate/Claus.
National Steel Co	Weirton, W. Va	60	Do.
United States Steel Corp	Clairton, Pa	40	Do.
Plants under construction:			
Bethlehem Steel Corp	Bethlehem, Pa	100	Sulfiban/Claus.
Shenango Inc	Pittsburgh, Pa	32	Do.
Commitments for construction:			
Armco Steel Corp	Middletown, Ohio	96	Firma Carl Still/Sulfuric Acid.
Jones & Laughlin Steel Corp.	Pittsburgh, Pa	80	Sulfiban/Claus.
Inland Steel Co	Indian Harbor, Ind	50	Vacuum Carbonate/Claus.
Wheeling-Pittsburg Steel Corp.	Follansbee, W. Va	95	Firma Carl Still/Sulfuric Acid.

Source: Massey, M. J., and R. W. Dunlap. Assessment of Technologies for the Desulfurization of Coke Oven Gas. AIME Ironmaking Proc. V. 34, 1975, pp. 583–603.

Hamilton and Rice described the commercial development of the United States Steel Corp.'s Phosam process for the recovery of coke-oven byproduct ammonia in the form of high-purity anhydrous liquid ammonia.[5]

COAL TAR AND DERIVATIVES

All oven-coke plants produced crude tar in quantities ranging between 5.87 and 9.72 gallons per ton of coal carbonized. Coke plants in California, Colorado, Utah, and West Virginia had the larger yields of tar because these plants used larger percentages of high-volatile coals.

Because 7.1% less coal was carbonized in oven-coke plants, tar production was 4.7% less than in 1975, despite a 2.8% increase in average tar yield.

Coke-plant operators consumed 55.0% of the crude tar produced. Of this quantity, 51.6% was processed (refined or topped) and 40.0% was burned as fuel without any processing. The remaining production, together with withdrawals from stock, was sold to tar-distilling plants for refining into a variety of tar-derived products.

Most of the crude tar that was processed in 1975 was subjected to topping, whereby distillate fractions, consisting mainly of low-boiling tar acids and bases, and naphthalene were obtained. The resulting residue (called soft pitch) was usually used for fuel. Furnace coke plants that were integrated with steel plants in particular benefited from this situation because they could sell the distillate and retain the soft pitch for use as fuel. However, the relative quantities of tar topped, burned, or sold depend on the availability and current market prices of crude tar, tar distillates, and other substitute fuels. Most of the merchant plant tar production was sold because merchant plants had little demand for pitch, which normally represented 65 to 92 volume-percent of the crude tar feed to the topping stills.

Most of the plants that processed crude tar recovered only crude chemical oil (also known as carbolic oil) and liquid still residues ranging up to soft pitch. Some of the larger plants recovered a number of tar-based products, including creosote oil, cresylic acid, cresols, naphthalene, phenols, xynols, pyridine, picoline, quinoline, and medium and hard pitch. Although statistics on many of these tar derivatives are not disclosed in this report because of

[4] Singleton, Alan H. and Gene Batterton. Coke Oven Gas Desulfurization Using the Sulfiban Process. AIME Ironmaking Proc., v. 34, 1975, pp. 604–610.

[5] Hamilton, C. W. Jr., and R. D. Rice. New Developments in the U.S.S. Phosam Process. AIME Ironmaking Proc., v. 34, 1975, pp. 622–641.

individual company confidentiality, the data were transmitted to the U.S. Tariff Commission for publishing with similar data from tar distillers and petroleum refiners, in monthly and annual reports on synthetic organic chemicals.

CRUDE LIGHT OIL AND DERIVATIVES

Crude light oil is a mixture of aromatic hydrocarbons, thiophene, mercaptans, hydrogen sulfide, and carbon disulfide that are absorbed from the coke-oven gas after tar, ammonia, and in some instances naphthalene have been removed. Crude tar has an insignificant content of crude light oil that is seldom recovered at coke plants. Practically all crude light oil produced at coke plants is recovered by absorption in which the gas is contacted with a high-boiling petroleum oil or a coal-tar-based distillate as the gas passes through absorption equipment. Crude light oil is stripped from the absorption oil by direct steam distillation. About 2.5 to 3.0 gallons (20 pounds) of crude light oil are usually recoverable per ton of coal carbonized. Yields vary with the kinds of coal carbonized and with operating conditions. An average of 2.55 gallons per ton of coal carbonized was recovered at 51 plants that extracted light oil in 1975. Yield per ton of coal was about the same in both merchant and furnace plants as in 1974. Eleven plants left the light oil in the gas to increase its calorific value.

Producers sold 50.8% of their crude light oil output. The increase of crude light oil sales in recent years is attributed to the inability of some plants to produce derivatives meeting the rigid specifications of dependable quality and competitively priced aromatic petrochemicals. Such plants sell crude light oil to petroleum-refining companies for processing with petroleum-derived fractions into benzene, toluene, and a number of other chemical intermediates.

As with other coal-chemical materials, yields of products derived from crude light oil vary, but about 86.5 volume-percent of the crude light oil processed was recovered in 1975 as salable products, comprising 61.0% as benzene, 11.7% as toluene, 2.1% as xylene, and 2.5% as solvent naphtha. About all of the benzene production was classed as specification grades. In past years, a large amount of motor-grade benzene was used to increase anti-knock properties of gasoline, but current petroleum-refining practices have all but eliminated this use for benzene.

The unit value of light oil derivatives sold in 1975 ranged from $0.749 per gallon for all grades of benzene to $0.355 per gallon average for all crude and refined solvent naphtha. The average value of all light oil products sold decreased 1.0% to $0.698 per gallon, compared with $0.705 per gallon in 1974.

WORLD REVIEW

World production of metallurgical coke in 1975 was estimated at 398.2 million short tons. This quantity was 1.7% less than the 1974 output, and the decrease was attributed to decreased production in West Germany, Italy, the U.S.S.R., the United States, and Japan.

Europe, with 56.2% of the total, led in world production, although European output was 0.6% less than in 1974. Asia, with eight producing countries, ranked second in output with 24.0%. North America, with only three producing countries, ranked third with 16.2%

Australia.—The Australian budget for fiscal year 1976, released on August 19, 1975, included a new export duty on coal of $7.20 per short ton. A further $13 million was demanded by the Queensland Government as additional royalties for exports from mid-August to October 31, the end of the Queensland fiscal year.

Utah Development Co., a 89% owned subsidiary of Utah International Inc., owned and operated four coking-coal mines in Queensland, Australia, with shipments primarily to Japanese and European customers. The subsidiary in mid-August 1975 boosted its prices retroactively for coking-coal deliveries to Japanese plants by $13.50 per short ton retroactive to April 1 and about $15.00 after July 1, 1975. Preliminary discussions were also held with European buyers with the intent of similarly raising prices there.

The Australian firm Oakbridge and Japan's Sumitomo Group agreed to develop Oakbridge's Clarence holdings near Lithgow, New South Wales, to a production level of 3.3 million short tons of coal annually by early 1980. A large portion of the production was to be processed into formed coal by Sumitomo. Oakbridge and Sumitomo have cooperated since 1971 to develop a process for formed coal—a "synthetic" coking coal made from a mixture of coals. Production at a 1.1 million short-ton level was scheduled to begin in 1978.

The Wilputte Corp. received a $32 million contract to engineer and manage the construction of a 36-oven battery at the Whyalla plant, South Australia, of Broken Hill Pty. Co., Ltd. The new battery of 5-meter-high ovens was designed to produce 365,000 tons of blast furnace coke annually from 540,000 tons of coal.

Brazil.—The Midrex Corp. and Usinas Siderurgicas de Minas Gerais, S.A. (Usiminas), Belo Horizonte, early in 1975 reached a technical cooperation agreement for the use of coke-oven gas and blast furnace top gas as a substitute for natural gas in a direct-reduction process. The agreement provided for a feasibility study and large-scale production using coke-oven and blast furnace top gases in the production of 1.0 to 1.2 million tons per year of Midrex metallized iron material for use in blast furnaces and Linz-Donawitz converters.

Midrex Corp. in November received a letter of intent from Usiminas for a series of agreements including a construction contract for two 440,000 short-ton-per-year modules using the Midrex direct-reduction process. The two modules are expected to begin operation in 1978 at Ipatinga, using coke-oven gas as a substitute for natural gas.

Island Creek Coal Co., a subsidiary of Occidental Petroleum Corp., in November 1975 agreed to supply Usiminas with 5 million tons of coking coal over the next 5 years. The agreement, valued at $258 million at current prices, involves about 1 million tons per year of high- and low-volatile coking coals from Island Creek's Virginia and West Virginia mines. Prices will be negotiated annually.

Canada.—During 1974, Kaiser Resources Ltd. produced about 5.29 million short tons of clean coking coal from its large Harmer Ridge surface mine and two underground mines located near Sparwood, British Columbia. The bulk of the coking coal was sent to Japan under a long-term agreement. The base price of Kaiser's Japanese contract, f.o.b. Roberts Bank, was increased progressively from $19.66 per short ton in June 1974 to $27.49 in November. By April 1975, the price was increased further to $44.15 per short ton. These higher coal prices and continued successful processing operations enabled the company in January 1975 to announce its first dividend to shareholders.

All of the 1974 clean coking coal production of approximately 2.2 million short tons by Fording Coal Ltd. came from a multiseam surface mining operation located 35 miles north of Sparwood. Nearly all of this production went to Japan under a long-term contract calling for shipments of 3.3 million short tons annually. The base price paid to Fording under the contract, f.o.b. Roberts Bank, was increased from $19.55 per short ton in April 1974 to $29.29 per short ton in September, retroactive to the beginning of 1974. On April 1, 1975, the price was increased to $42.73 on an interim basis.

Coleman Collieries Ltd. shipped approximately 880,000 tons of clean coking coal to Japan in 1974 from three mines in the Crowsnest Pass area of Alberta. In April 1974 Coleman negotiated a price of $26.36 per short ton, f.o.b. Port Moody, for clean coking coal shipped to Japan under contract. In September 1974 the price was raised to $28.15 per short ton. Effective April 1, 1975, Coleman agreed to a price of $41.71 per long ton under a new 3-year agreement calling for shipments of 825,000 short tons in 1975, increasing to an annual rate of 990,000 short tons commencing in April 1976.

Cardinal River Coals Ltd., The Canmore Mines, Ltd., and Gregg River Resources Ltd. either shipped or signed contracts to ship in 1974 and following years coking coal to Japanese steelmakers from mines in Alberta.

The Bureau estimated the exports from the United States of bituminous metallurgical coals in 1974 and 1975, in thousand short tons as follows: [6]

Destination	1974	1975
Canada	7,488	7,622
Latin America	2,761	3,274
Europe:		
EEC	10,915	9,802
Other Europe	2,899	4,180
Asia	27,604	25,742
Total	51,667	50,620

[6] U.S. Bureau of Mines. International Coal Trade. V. 45, No. 6, June 1976, p. 5.

During 1974, McIntyre Mines Ltd. produced 1.65 million short tons of clean coking coal from its No. 2 underground mine and its No. 8 and No. 9 open pit mines near Grande Cache, Alberta. In April 1974, McIntyre reached agreement with Japanese customers for delivery of 1.65 million short tons on a 1-year contract with prices based on Eastern U.S. producer prices for coal of equal rank, quality, and coking properties. One-year contracts were also made with Bethlehem Steel Corp. for 330,000 short tons and The Steel Company of Canada, Ltd., for 220,000 short tons on the same pricing arrangement. In October 1974, McIntyre concluded agreements with its Japanese customers for an advance of $16.3 million on coal deliveries to be received before April 1, 1975, and an immediate price advance of $10.00 per short ton to $36.57 f.o.b. Vancouver. In addition, a new 3-year agreement was finalized calling for delivery of 1.65 million short tons per year beginning April 1, 1975. In April 1975 a f.o.b. Vancouver price of $53.25 was set for McIntyre coal shipped to Japan. In 1975, McIntyre planned to ship 220,000 short tons to The Steel Company of Canada, Ltd., in Hamilton, Ontario, and 165,000 short tons to Sydney, Nova Scotia.

In 1977–78, Canada will have over 22,000 short tons per day of coke capacity, equal to about 7.5 million short tons per year.

In 1974, an average of 1.44 tons of coking coal was required to produce a ton of coke in Canada. The amount of actual coke consumed per short ton of hot metal produced in blast furnaces was 1,020 pounds, down 10 pounds from the rate in 1973. About 66% of the coking coal used in Canada in 1974 was imported from the United States. Approximately 8.3 million short tons of coking coal was carbonized to produce 6.0 million tons of coke (including 5.0 million tons of blast furnace coke).

Three steel companies in Ontario operated coke-oven plants in Hamilton and Sault Ste. Marie. All had captive U.S. mines and long-term contracts. In Sydney, Nova Scotia, the Sydney Steel Corp. used a combination of Nova Scotia and U.S. coals to produce coke for its steel mill. The integrated steelmakers accounted for over 90% of the Canadian coke production.

The Algoma Steel Corp., Ltd., of Sault Ste. Marie, Ontario, began operation of its new No. 9 coke battery in late 1975. Rehabilitation of the No. 7 coke battery was planned for 1975. Construction of the new No. 10 coke battery, identical in size to the No. 9, began in 1974.

France.—Blast furnace trials using 5,000-ton lots of formed coke produced by the HBNPC process were carried out by USINOR in France. Thirty-three to 44% of the normal coke was replaced in two small blast furnaces that worked regularly, despite an increase in resistance to blast.[7]

Japan.—The quantity of coking coals imported by Japan during fiscal year 1974 increased 11%, while the cost during the same period increased by a factor of 2.24 times the average cost for fiscal 1973. The main reasons given in the Japanese steel industry were the labor unrest in Australia and the expectation of a long strike by U.S. coal miners. These reasons caused Japanese buyers to purchase any U.S. coals offered regardless of price and shipping cost. The average import cost per short ton of U.S. coking coal in January 1975 was $97.35, compared with $33.40 in January 1974. In January 1974 1.65 million short tons was imported, and a peak monthly quantity of 3.2 million short tons was reached in November 1974. Only the United States was able to significantly increase the quantity exported to Japan. The imports from the United States accounted for 41% of the total 69.2 million short tons of coal imported in 1974.

The Nippon Steel Corp., Tokyo, after 3 years of experimentation, was successful in briquetting noncoking coal and using the 2-inch-square briquets to furnish 6% to 10% of the coal mixtures carbonized in coke ovens. A 3,000-ton-per-day-capacity plant started operation in September 1975 at the Fukuyama Works of NKK (Nippon Kokan); about half of the 450,000 tons of coke produced monthly was based on coke-oven charges containing varying percentages of briquets.

[7] Burteaux, Internat. Iron and Steel Cong., Dusseldorf, West Germany, 1974, Metal Paper 1.2.2.6, 14 pp. (in French).

TECHNOLOGY

Summaries of some of the test data reported in the 1974 Annual Report of the British Carbonization Research Association (BCRA) follow:

1. The omission of a high-rank 204-class coal from a wet Durham blend caused a greater deterioration in the M 40 index than that observed with preheated blends. Preheating the standard and inferior blends caused similar changes whereby the M 40 index improved by about nine and the M 10 index improved by about one. Oiling a single preheated coal charge with 1% of hot heavy fuel oil appeared to have effects similar to those observed with the Durham blend in that the charge bulk density appeared to decrease, the increase (by preheating) in the throughput of the dry coal was reduced from about 40% to 25%, and the coke properties appeared to be unchanged. In tests using a commercial coal blend from Teeside and a medium-rank coal from Yorkshire, increases in the bulk density of both wet and preheated charges caused linear reductions in the main size (M 40 and M 10) indices and porosity of the coke, the apparent relative density increased linearly, and the true relative density was unaffected.

2. BCRA studied the value of a loose chargeable matrix of material around commercial coal briquets in a coke oven. Alone, the briquets could not be discharged from a conventional oven by a conventional pusher machine. A variety of coals, coke breeze, pitch, etc., was tested to act as a matrix surrounding the briquets. Although the results of these tests were not encouraging, a blend of 70% briquets and 30% of selected poorly coking coal was carbonized in a 10-ton oven. No difficulties occurred in charging the oven, but discharging was extremely difficult and for this reason the method was considered impractical for commercial application.

3. A study of the carryover of solids from preheated and wet coal during its gravity charging into coke ovens indicated that the total carryover obtained with on-main charging could be as much or even more than 0.5% of the weight of preheated coal charged to the oven. For wet charges the carryover with on-main charging was much smaller. When charging preheated coal, the dry solids washed out from the gas on a separate charging main constituted about 88% of the total dry solids carried over. The amount of tar in the charging-main solids was about 6% by weight of the dry solids.

4. The results of tests on the behavior of coal during carbonization suggested that the retention of phosphorus in cokes prepared from low- and medium-volatile coals was influenced by carbonizing temperature, increasing as the carbonizing temperature was raised from 800° C to 1,200° C.

Phosphorus retention apparently also increased as the rank of coal decreased; 30% to 40% of the phosphorus present in medium- and high-rank coals was retained in the coke, but 60% to 80% was retained in coke produced from a low-rank, high-volatile coal.

5. The determination of nitrogen in coke is of importance in making accurate heat balances and because of the significant release of oxides of nitrogen into the atmosphere when coke is burned in sintering processes. Investigations using cokes of varying reactivity compared their nitrogen contents as determined by a number of methods, including a modified version of the steam-distillation method of Beet and Belcher dating from 1938.

6. Conclusions drawn from approximately 150 tests in a coke-oven-gas-fueled, 350-kilogram oven used to carbonize three coals and three commercial blends of varying properties at wall temperatures ranging from 1,080° to 1,630° C (equivalent to center-of-charge temperatures of 1,050° to 1,600° C) follow: (a) Heat consumption at the maximum wall temperature (1,630° C) was more than four times that required at a wall temperature of 1,080° C, (b) the coke yield appeared to be independent of wall temperature, and (c) the proportion of plus 80-millimeter-size coke decreased from about 60% at 1,080° C to 17% at 1,600° C, while the yield of 20- to 80-millimeter-size increased from 23% of the charge weight at 1,080° C to 58% at 1,600° C. These size relationships were equally applicable to the cokes made from wet and preheated coal.

7. Micum tests to assess the resistance to breakage were made on samples sized as plus 60 millimeters and 20 to 80 milli-

meters. With increasing wall temperature the M 40 indices on the plus 60- and 20- to 80-millimeter sizes decreased, and the size-degradation indices on the plus 60- and 20- to 80-millimeter sizes increased. The M 10 index generally was only slightly affected, but for cokes made from the lower rank coals, it was significantly improved; for some coals minimum M 10 indices (20 to 80 millimeters) were observed at carbonizing rates of 40 to 50 millimeters per hour and a coke discharge temperature of 1,050° C. In this respect preheated coal charges gave approximately the same response to the temperature of carbonization as did wet coal charges.

8. The reheating (at a wall temperature of 1,625° C) of coke made at a wall temperature of 1,080° C had little effect on its physical properties other than a reduction in mean size caused by handling. Such coke, despite this mechanical breakage, remained larger and had a higher M 40 index than coke produced by direct carbonization at 1,625° C.

9. A considerable part of the reduction in the Micum indices that occurred at higher wall temperatures was attributed to the smaller size of the coke produced at higher wall temperatures as a reasonable consequence of greater thermal stresses that caused increasing fissuring. The tensile strength of the smaller sized coke free of major fissures was greater at a wall temperature of 1,500° C than at 1,080° C.

10. Extra-high-temperature carbonization produced additional removal of sulfur, most probably by decomposition of ferrous sulfide derived from pyrites in the coal carbonized. About 10% more sulfur was removed at 1,625° C than at 1,080° C. Reheating of coke to a center-of-charge temperature of about 1,600° C resulted in a generally similar reduction of the sulfur content. With increasing temperatures of carbonization and of free space, methane and ethylene decomposed mainly to hydrogen and carbon with a corresponding decrease in calorific value of the coke-oven gas mixture. As wall temperature increased, the toluene-insoluble content and density of the tar increased, and the percentage distilling up to 350° C and the phenol content both decreased.

11. The results of the extra-high-temperature carbonization in the 350-kilogram test oven, fabricated using mullite refractories, suggested an increased oven throughput (from 40 to 120 kilograms per hour per cubic meter of charge volume), a coke yield in the preferred size range (from one-quarter to two-thirds sized 20 to 80 millimeters); and a 10% decrease in the sulfur content of the coke. Possible disadvantages to the application of extra-high-temperature carbonization to commercial practice include the high energy requirement resulting from high heat losses, the difficulty of maintaining efficient temperature control and good temperature distribution throughout the oven, the attack on the refractory material resulting from ash fusion, the difficulties and hazards in large-scale operation, and an increase in carbon buildup and in carryover of solids. It was considered that because the disadvantages outweighed the gains, any practical application of extra-high-temperature carbonization seemed remote. This conclusion was reinforced by the fact that most of the advantages can be achieved by carbonizing preheated coal at a wall temperature in the 1,250° C to 1,300° C range.[8]

A Koppers Co. Inc. invention protected by British Patent 1,386,681 reduced the excessive cooling of the regenerator sections under the end flues of coke ovens due to radiant heat loss and ingress of cold air. This was achieved by use of an array of ports having a Venturi or cylindrical shape with flared ends; the top and bottom diameters of these ports were varied along the regenerator so that a uniform upflow distribution of air or lean gas was obtained.

Didier Engineering GmbH and Bergiverksverbland GmbH of West Germany received British Patent 1,387,900 for the programed heating of individual ovens in a coke-oven heating system. Each heating wall is made up of groups of flues, each group consisting of three or four flues side by side in a direction parallel to the long axis of the battery. All the flues adjoining the oven walls are on ascending flow; that is, combustion in them is continuous. The intermediate flue or flues carry away the hot waste gas. Below each group of flues is a metallic recuperator in which heat is transferred from the waste gas to the air or lean gas. The air and lean gas emerge

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[8] British Carbonization Research Association. Annual Report. 1974, 60 pp.

into heating flues at a number of levels to allow the vertical distribution of heat to be regulated.

The principles of the Lurgi-Ruhrgas process for the carbonization of coal using fine coke as a heat carrier were described. Its use for high-temperature carbonization to produce coke breeze and gas and for low-temperature carbonization to produce semicoke, tar and oil was discussed. Experience with a large-scale test plant at Dorsten, coupled with a steam-raising plant, was summarized, and commercial applications were considered.[9]

The effects of coking rate and final temperature of carbonization in conventional ovens were described.[10] When a single blend of coal was carbonized at three coking rates (30 to 33 millimeters per hour) to a constant final temperature, the mean size and the shatter resistance of the coke decreased but the strength of the coke substance improved as the coking rate was increased. When two blends (one with an increased content of high-volatile coal) were carbonized in commercial ovens at two different flue temperatures and two different final temperatures, an increase in coking rate reduced the mean size of the coke, but the final temperature had little effect. Similarly the shatter resistance was reduced by an increase in coking rate but improved by increases in both variables. An increase in final temperature raised the true density of the coke and reduced its electrical resistivity and reactivity. It was also shown that the effect of an increase in the proportion of weakly coking coal could be offset by raising the coking rate and final temperature.

Reeve and Paulencu indicated that pulverized coke fines can be used to reduce requirements for low-volatile coal in blends used to make coke having acceptable strength for blast furnace use. The coke quality is influenced by the quantity and size of the coke fines added and by the coke-oven operating conditions.[11]

In a paper from National Smokeless Fuels Ltd. (NSF) reviewing the consumption of foundry coke in particular by the iron-castings industry in Britain, specifications agreed for foundry coke produced at five NSF coking plants are quoted. They include a maximum sulfur content of 0.85% to 1.00%, a minimum 2-inch shatter index of 90, and a minimum mean size of 4.0 to 4.2 inch. The costs of cast iron production are discussed with particular reference to the requirements of clean air legislation.[12]

Fundamental data on the operation of biological treatment systems for coke plant waste water were discussed.[13]

The basic features of the Bergbu-Forschung formed-coke process were described, and the results of blast furnace trials using the product were summarized. It was possible to use weakly caking coals as the binder component of the briquetting mix if pitch, or the heavy tar from the char-production stage, or petroleum residue was added to the mix. Details were given for 300-ton-per-day and 650-ton-per-day pilot plants. The dependence of capital and operating costs on the volatile matter of the coals used was clarified.[14]

Accounts of the following formed-coke processes were summarized.[15] The processes, as known by their owners or developing institutions, are FMC, BFL, Ancit, HP-NPC, Republic Carbon Products Co., Department of Energy, Mines & Resources of Canada, U.S. Bureau of Mines, Auscoke, University of Ife (Nigeria), and the National Research Institute for Pollution and Resources (Japan). Items discussed randomly in relation to the 10 processes included: Equipment, coal and other materials used in blends, carbonization conditions, operating difficulties, yields, chemical and physical analyses, flowsheets, and economics.

The chemical, physical, and mechanical characteristics of cokes were studied to obtain guidance in formulating the blend composition and coal-preparation conditions for the production of metallurgical coke. The effects on tensile strength and reactivity of coke were discussed.[16]

The mechanism and identification of the

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[9] Doring, H. Erdol Und Kohle, v. 5, No. 28, 1975, pp. 225–232, (in German).

[10] Skyiar, M. G. Coke Chem. U.S.S.R., v. 7, 1974, pp. 16–21.

[11] Reeve D. A., and H. N. Paulencu. The Evaluation of Coal Blends Containing Antifissuring Agents for Coke Making. AIME Ironmaking Proc., V. 34, 1975, pp. 135–159.

[12] Hill, J. D. Foundry Trade J., v. 138, No. 3036, 1975, pp. 201–207.

[13] De Falco, A. J. Biological Treatment of Coke Plant Waste Waters. Iron and Steel Eng., v. 52, No. 6, June 1975, pp. 39–41.

[14] Schmalfeld P. and R. Rammler. Stahl & Eisen, v. 94, No. 16, 1974, pp. 701–710 (German).

[15] BCRA Review. V. 2, No. 2, April–June 1975, pp. 103–105.

[16] British Carbonization Research Association. Further Studies of the Influence of Additives in a Coke Oven Charge on the Tensile Strength and Reactivity of Coke. Carbonization Res. Rept. 8, October 1974, 15 pp.

principal factors influencing the formation of pores in semicoke and coke were evaluated.[17]

A new process for recycling and upgrading 450 tons per day of minus 3/16-inch coke fines at the Clairton coke works of the United States Steel Corp. was described.[18]

A reliable method for evaluating coking coal before it enters the steel plant complex was thoroughly described and evaluated by Thompson and Benedict, who relate the petrographic composition of coal to coking behavior and coke quality.[19]

During 1973 and 1974, Salem Corp.'s partnership, Coaltek Associates, licensed nine Coaltek systems for preheating coal and charging it by pipeline direct to coke ovens. Four of these installations are located in the United States and five overseas. In 1975, five were operating; the balance were expected to go on line in 1976. As anticipated on any new process, certain difficulties were experienced in startups; however, the Coaltek system is providing the advantages claimed by its developers—improving coke quality, utilizing less costly and more readily available grades of coal, substantially increasing coke production, and minimizing air pollution.

Proposed standards for coke-oven emissions as established by the Labor Department's Occupational Safety and Health Administration (OSHA).[20] A study made for OSHA estimates that the cost of compliance for the coke industry will be $495 million in added capital expenditures ($7.45 per ton of coke) and about $295 million for annual operating costs ($4.45 per ton of coke).

On August 4, the president of the United Steelworkers of America (USWA) stated that OSHA's standards did not contain sufficient provisions for enforcement and sidestepped recommendations made the Labor Department's own advisory committee. On August 6, the president of the American Iron and Steel Institute (AISI) classed as inaccurate the USWA statement that the Labor Department favored industry by largely ignoring standards recommended by a committee composed of people from industry, labor, and the public. The AISI spokesman also said the proposed standards for particulate emissions appeared to be unattainable even with the implementation of the suggested engineering controls because the different batteries in the United States have ovens ranging from 10 to 20 feet high, with capacities of 12 to 36 tons of coal, and ages ranging up to 45 years. Only about one-third of the oven batteries have double collecting mains, and the majority of the batteries have luted rather than self-sealing doors.

OSHA said that because it did not know what "agent" was causing the health problem, usually related to lung cancer development, Federal standards should be based on the emission of an indicator substance. The proposed Federal standards would use benzo-a-pyrene (BAP) as an indicator of coke-oven emissions. Despite this situation OSHA said it will retain its proposal to limit worker exposure in a 40-hour workweek to no more than an 8-hour time-weighted average of 0.3 milligram of respirable particles per cubic meter of air.

On November 4, 1975, steel industry representatives and union officials, in a surprise move, said they would try privately to form a joint management-labor proposal on coke-oven emission standards. Prior to the announcement, industry officials claimed that the cost of the OSHA standards was too harsh on industry, while the USWA officials called the proposed standards a giveaway to industry.

In December 9 public hearings, the chairman of the AISI's Coke Committee told OSHA rulemakers that general uniform standards that may be practical at one coke plant might not work at another. The chairman listed major differences in configurations of coke batteries in the United States. The differences must be considered in implementing specified engineering controls and administrative procedures for a given battery.

The Jones & Laughlin Steel Corp. and the Environmental Protection Agency (EPA) agreed on an environmental consent order that gave new life to the cor-

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[17] British Carbonization Research Association. A Preliminary Study of Pore Formation During the Carbonization of Coal. Carbonization Res. Rept. 9, October 1974, 22 pp.

[18] Larimer T. M., J. P. McGinnes, and R. W. Shoenerger. Development of Coke Breeze Recycling. Iron and Steel Metals, v. 3, No. 2, February 1976, pp. 32–37.

[19] Thompson, R. R., and L. G. Benedict. Coal Consumption and Its Influence on Cokemaking. Iron and Steel Metals, v. 3, No. 2, February 1976, pp. 23–31.

[20] Federal Register, v. 40, No. 148, July 31, 1975, part III, pp. 33268–33282.

poration's aging Pittsburgh works and could become the blueprint for controlling coke plant pollution throughout the steel industry. The agreement noted the firm's doubts about its ability to meet air pollution laws, despite its substantial good-faith effort to comply, while preserving its legal right to challenge the regulations that cannot be met by current technology.

Duncan described the actions taken in Ontario to establish air emission regulations and guidelines as governed by the Federal and Provincial legislation concepts which, although very different, do produce consistent results.[21]

Specifications describing coke-side pollution control equipment were described in three patents. In one Simon-Carves design, covered in British Patent 1,373,164, the end walls and outer side wall of the coke car are built-up to the height of the coke guide so that the coke car is entirely enclosed during pushing. A second Simon-Carves development, protected by British Patent 1,368,104, uses a smoketight hood supported by the guide machine to cover the coke car and the coke guide. Both Simon-Carves systems use trunking conduits provided with water troughs. In a third arrangement, covered under British Patent 1,372,573 and assigned to Harting, Kuhn & Co. Maschinefabrik Gmbh, air pollution is prevented by a hood that abuts the coke guide, extends over the coke car, and has associated ducts connected to venturi scrubbers for eliminating the fumes. The hood and scrubbers are mounted on a carriage supported by a framework parallel to the coke-car track. British Patent 1,372,636, assigned to the Wilputte Corp., covers a coke-oven door-frame cleaning mechanism that has sets of spring-loaded scraper blades that can be reciprocated along guided paths by hydraulic rams.

Equipment and practices to control air emissions were summarized by Voelker.[22] Topics covered included oven charging, coke quenching, other intermittent emissions, continuous emissions, and personal environment.

The Granite City Steel Div. of National Steel Corp. successfully tested a pilot model and applied for a patent on a "one-spot coke receiver system." The system reportedly fully encloses the coke push and captures its emissions by an enclosed container car that remains stationary during the push. The design of the coke receiver car causes the incandescent coke to flow in two directions, filling the entire car. A 50,000-cubic-foot-per-minute fan on a trailer car draws emissions from the coke-pushing operation into a high-energy venturi scrubber. It is claimed that the new control system will not increase the exposure of the coke-oven worker to smoke as has happened when using coke-side sheds.

The Salem Corp. of Pittsburgh, Pa., obtained British Patent 1,375,345 relating to a continuous coke quencher, consisting of two contiguous hoppers, mounted on a carriage with associated fume-extraction equipment and a rotary table beneath each hopper on which the coke is quenched by water sprays.

The first trials of a wet electrostatic precipitator on a coke-side enclosure at a St. Louis, Mo., coking plant were described. The trials indicated that the precipitator was more efficient than low- or high-energy scrubbers operated in parallel, removing more than 98.5% of the bimodal mixture of 3- to 30-micrometer carbon particles and submicrometer hydrocarbon droplets. Wet precipitators for coke-side enclosure were ordered by two North American coke producers.[23]

The Gewerkschaft Schalker Eisenhutte obtained British Patent 1,377,894 for a burner that assures the stable combustion in a washer-type car of the gases extracted from a coke oven during charging. The combustion chamber surrounding the burner head contains an electric igniter, ports for admitting secondary air, and a spoiler ring. The combination produces a toroidal vortex downstream from the burner head and stabilizes the flame despite variations in the draft produced by the suction fan.

The U.S.S. Engineers and Consultants Inc. obtained British Patent 1,382,085 covering a modification of the Wolff self-sealing system for coke-oven doors. Some hook bolts are replaced by bolts with disks welded to their outer ends. The disks on each bolt carry a pin extending into a

[21] Duncan, C. E. Discussions of Coke Oven Controls as Related to the Province of Ontario. AIME Ironmaking Proc., v. 34, 1975, pp. 238–241.
[22] Voelker F. C., Jr. A Contemporary Survey of Coke-Oven Air Emissions Abatement. Iron and Steel Eng., v. 52, No. 2, February 1975, pp. 57–64.
[23] Bakke, E. J. Air Pollution Control Assoc., v. 25, No. 2, 1975, pp. 163–167.

slotted wedge plate, the slanting edge of which bears against the bolt. Rotation of the bolt pushes the sealing strip into contact with the door frame. The bolt is clamped in position by a locknut.

New designs of pipeline-charged high-battery ovens, first placed in operation by Inland Steel Co. on August 13, 1974, and by Jones & Laughlin Steel Corp. on December 25, 1975, have complicated the refractory specifications. In the 200-foot-high preheat coal chambers, where abrasion and moisture abound, a high-alumina castable was being tried in 1975. Although their output coal temperatures are only 450° to 550° F, preheat chambers are the heart of the charging system.

IHI Heavy Industries Co., Ltd., received an order from Kawetetsu Chemical Industry Co., Ltd., of Japan for a new dry-quenching plant including three blocks of tower boilers and a coke-handling system. Each block consists of a cooling tower with a coke capacity of 61.6 short tons per hour, a heat recovery boiler (steam capacity of 33 short tons per hour at 18 kilograms per square centimeter gage and 229° C), and an inert gas circulating system. The dry quenching system cools the coke from about 1,000° C to below 250° C while effectively recovering sensible heat by using circulating inert gas instead of water sprays. IHI licensed the dry-quench technology in 1974 from the U.S.S.R.

Tall-coke-oven design requires the use of high-density silica brick, containing 95% to 96% SiO_2 and weighing 114 to 120 pounds per cubic foot. Experimental brick weighing 122 pounds per cubic foot were in use. Their thermal conductivity was as much as 14.5 Btu per hour, per square foot, per degree F, per inch, at 1,500° F.

Two classes of silica brick produced in large quantities for use in coke oven construction and repair are a superduty brick with total alumina, titania, and alkalies held to 0.2% to 0.5%; and conventional silica brick containing between 0.5% and 1.2% total alumina, titania, and alkalies. The rest of the chemical content of such brick for coke ovens specifies 94% to 95% SiO_2 and approximately 3% maximum CaO and MgO as bonding agents. Normal tests applied to silica brick include density, specific gravity, porosity, high-temperature strength, and cold-crushing strength. Silica brick exhibit trivial expansion or contraction over the 1,200° to 2,700° F operating range of a coke battery. Superduty silica brick have shape stability within a few degrees of melting because they do not have a softening range like fireclay brick.

Table 2.—Statistical summary of the coke industry in the United States in 1975

	Slot ovens	Beehive ovens	Total
Coke produced:			
At merchant plants ---- thousand short tons	4,716	(1)	(1)
At furnace plants [2] ---- do	51,778	(1)	(1)
Total [3] ---- do	56,494	713	57,207
Breeze produced ---- do	4,281	--	4,281
Coal carbonized:			
Bituminous:			
Thousand short tons	82,147	1,128	83,274
Value (thousands)	$3,631,600	W	W
Average per ton	$44.21	W	W
Anthracite:			
Thousand short tons	326	--	326
Value (thousands)	$14,098	--	$14,098
Average per ton	$43.25	--	$43.25
Total: [3]			
Thousand short tons	82,472	1,128	83,600
Value (thousands)	$3,645,697	W	W
Average per ton	$44.21	W	W
Average yield in percent of total coal carbonized:			
Coke	68.50	63.21	68.43
Breeze (at plants actually recovering)	5.21	--	5.21

See footnotes at end of table.

Table 2.—Statistical summary of the coke industry in the United States in 1975—Continued

	Slot ovens	Beehive ovens	Total
Coke used by producing companies:			
In blast furnaces:			
Thousand short tons	46,233	--	46,233
Value (thousands)	$3,885,045	--	$3,885,045
In foundries:			
Thousand short tons	220	--	220
Value (thousands)	$27,045	--	$27,045
For other industrial uses:			
Thousand short tons	191	--	191
Value (thousands)	$16,266	--	$16,266
Breeze used by producing companies:			
In steam plants:			
Thousand short tons	257	--	257
Value (thousands)	$4,413	--	$4,413
In agglomerating plants:			
Thousand short tons	1,202	--	1,202
Value (thousands)	$36,900	--	$36,900
For other industrial uses:			
Thousand short tons	715	--	715
Value (thousands)	$20,615	--	$20,615
Coke sold (commercial sales):			
To blast furnaces:			
Thousand short tons	2,682	708	3,390
Value (thousands)	$197,572	$46,139	$243,711
Average per ton	$73.67	$65.17	$71.89
To foundries:			
Thousand short tons	2,392	--	2,392
Value (thousands)	$254,789	--	$254,789
Average per ton	$106.52	--	$106.52
To other industrial plants:			
Thousand short tons	722	(4)	722
Value (thousands)	$55,611	(4)	$55,611
Average per ton	$77.02	(4)	$77.02
For residential heating:			
Thousand short tons	(5)	--	(5)
Value (thousands)	(5)	--	(5)
Average per ton	(5)	--	(5)
Breeze sold (commercial sales):			
Thousand short tons	1,953	--	1,953
Value (thousands)	$62,897	--	$62,897
Average per ton	$32.21	--	$32.21
Coal-chemical materials produced:			
Crude tar:			
Thousand gallons	645,537	--	645,537
Gallons per ton of coal	7.83	--	7.83
Ammonia: [6]			
Thousand short tons	534	--	534
Pounds per ton of coal	15.98	--	15.98
Crude light oil:			
Thousand gallons	194,814	--	194,814
Gallons per ton of coal	2.55	--	2.55
Gas:			
Million cubic feet	895,279	--	895,279
Thousand cubic feet per ton of coal	10.86	--	10.86
Percent burned in coking process	39.60	--	39.60
Percent surplus used or sold	58.89	--	58.89
Percent wasted	1.51	--	1.51
Value of coal-chemical materials used or sold:			
Crude tar and derivatives:			
Used .... thousands	$93,031	--	$93,031
Sold .... do	$133,252	--	$133,252
Ammonia products [7] .... do	$32,753	--	$32,753
Crude light oil and derivatives [8] .... do	$102,228	--	$102,228
Surplus gas .... do	$292,694	--	$292,694

W Withheld to avoid disclosing individual company confidential data.
[1] Not separately recorded.
[2] Plants associated with iron blast furnaces.
[3] Data may not add to totals shown because of independent rounding.
[4] Included with beehive coke sold "to blast furnace plants" to avoid disclosing individual company data.
[5] Included with "To other industrial plants" to avoid disclosing individual company confidential data.
[6] In terms of sulfate equivalent.
[7] Includes ammonium sulfate, ammonia liquor, and diammonium phosphate.
[8] Includes intermediate light oil.

Table 3.—Summary of oven-coke operations in the United States in 1975, by State

State	Plants in existence Dec. 31	Coal carbonized (thousand short tons)	Yield of coke from coal (percent)	Coke produced (thousand short tons)
Alabama	7	6,755	69.43	4,690
California, Colorado, Utah	3	4,796	62.47	2,996
Illinois	4	3,087	62.33	1,924
Indiana	6	13,822	66.89	9,246
Kentucky, Missouri, Tennessee, Texas	5	2,596	67.33	1,748
Maryland and New York	4	7,512	70.53	5,298
Michigan	3	4,497	72.12	3,243
Minnesota and Wisconsin	3	1,071	72.83	780
Ohio	12	12,296	68.86	8,467
Pennsylvania	12	22,004	69.97	15,395
West Virginia	3	4,037	67.08	2,708
Total in 1975 [1]	62	82,472	68.50	56,494
At merchant plants	14	6,490	72.67	4,716
At furnace plants	48	75,982	68.15	51,778
Total in 1974	62	88,854	68.36	60,737

[1] Data may not add to totals shown because of independent rounding.

Table 4.—Summary of beehive-coke operations in the United States in 1975, by State

State	Plants in existence Dec. 31	Coal carbonized (thousand short tons)	Yield of coke from coal (percent)	Coke produced (thousand short tons)
Pennsylvania, Virginia, West Virginia:				
Total in 1975	4	1,128	63.21	713
Total in 1974	5	1,340	63.06	845

Table 5.—Production of oven and beehive coke in the United States, by month

(Thousand short tons)

Month	1974 Total [1]	1974 Daily average [2]	1975 Total [1]	1975 Daily average [2]
Oven coke:				
January	5,422	175	4,924	159
February	4,974	178	4,750	170
March	5,265	170	5,324	172
April	5,255	175	5,030	168
May	5,369	173	5,052	163
June	5,218	174	4,765	159
July	5,251	169	4,532	146
August	5,219	168	4,427	143
September	5,056	169	4,250	142
October	5,214	168	4,527	146
November	4,427	148	4,365	146
December	4,067	131	4,549	147
Total [1]	60,737	166	56,494	155
Beehive coke:				
January	67	2	70	2
February	65	2	68	2
March	68	2	67	2
April	70	2	62	2
May	68	2	56	2
June	66	2	52	2
July	61	2	59	2
August	81	3	60	2
September	83	3	62	2
October	87	3	60	2
November	64	2	57	2
December	62	2	40	1
Total [1]	845	2	713	2
Total:				
January	5,489	177	4,994	161
February	5,038	180	4,818	172
March	5,333	172	5,391	174
April	5,325	178	5,092	170
May	5,438	175	5,108	165
June	5,285	176	4,817	161
July	5,312	171	4,591	148
August	5,300	171	4,487	145
September	5,139	171	4,312	144
October	5,301	171	4,586	148
November	4,491	150	4,422	147
December	4,130	133	4,589	148
Total [1]	61,581	169	57,207	157

[1] Data may not add to totals shown because of independent rounding.
[2] Daily average calculated by dividing monthly production by number of days in month.

Table 6.—Production of oven coke in the United States, by type of plant
(Thousand short tons)

Month	1974 Merchant plants	1974 Furnace plants	1975 Merchant plants	1975 Furnace plants
Production:				
January	446	4,976	390	4,534
February	425	4,549	372	4,378
March	445	4,820	429	4,895
April	438	4,817	399	4,631
May	447	4,922	406	4,646
June	437	4,782	380	4,385
July	428	4,823	377	4,154
August	425	4,793	388	4,039
September	416	4,640	384	3,866
October	429	4,784	409	4,118
November	417	4,010	392	3,973
December	354	3,714	389	4,160
Total [1]	5,106	55,630	4,716	51,778
Daily average:				
January	14	161	13	146
February	15	162	13	156
March	14	155	14	158
April	15	161	13	154
May	14	159	13	150
June	15	159	13	146
July	14	156	12	134
August	14	155	13	130
September	14	154	13	129
October	14	154	13	133
November	14	134	13	132
December	11	120	13	134
Average for year	14	152	13	142

[1] Data may not add to totals shown because of independent rounding.

Table 7.—Production of oven coke and number of plants in the United States by type of plant

Year	Number of active plants [1]		Coke produced (thousand short tons)		Percent of production	
	Merchant plants	Furnace plants	Merchant plants	Furnace plants	Merchant plants	Furnace plants
1971	16	[2] 49	5,567	51,097	9.8	90.2
1972	14	[2] 49	5,626	54,228	9.4	90.6
1973	14	[2] 49	5,271	58,225	8.3	91.7
1974	14	48	5,106	55,630	8.4	91.6
1975	14	48	4,716	51,778	8.3	91.7

[1] Includes plants operating any part of the year.
[2] Includes one tar-refining plant.

Table 8.—Production of coke in the United States, by State
(Thousand short tons)

State	1974	1975
Oven coke:		
Alabama	5,122	4,690
California, Colorado, Utah	3,320	2,996
Illinois	1,912	1,924
Indiana	9,073	9,246
Kentucky, Missouri, Tennessee, Texas	1,920	1,748
Maryland and New York	6,457	5,298
Michigan	3,259	3,243
Minnesota and Wisconsin	954	780
Ohio	8,843	8,467
Pennsylvania	16,323	15,395
West Virginia	3,555	2,708
Total [1]	60,737	56,494
Beehive coke:		
Pennsylvania	845	713
Virginia	(2)	(2)
West Virginia	(2)	(2)
Total	845	713
Grand total [1]	61,581	57,207

[1] Data may not add to totals shown because of independent rounding.
[2] Included with Pennsylvania to avoid disclosing individual company confidential data.

Table 9.—Breeze recovered at coke plants in the United States in 1975, by State

(Thousand short tons and thousand dollars)

State	Yield per ton of coal [1] (percent)	Produced (quantity)	Used by producers: In steam plants		Used by producers: In agglomerating plants		Used by producers: For other industrial use		Sold		Stocks, Dec. 31 (quantity)
			Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	
Oven coke:											
Alabama	4.08	274	--	--	(2)	(2)	25	1,003	144	5,010	32
California, Colorado, Utah	6.07	291	--	--	142	3,667	19	471	124	4,100	47
Illinois	8.13	251	(2)	(2)	(2)	(2)	45	984	111	3,176	45
Indiana	7.32	1,012	(2)	(2)	342	12,645	206	5,466	377	11,504	342
Kentucky, Missouri, Tennessee, Texas	6.42	164	(2)	(2)	--	--	72	1,851	(4)	(4)	39
Maryland and New York	5.26	391	142	2,458	(2)	(2)	45	963	105	3,183	161
Michigan	5.10	229	--	--	--	--	(3)	(3)	266	8,596	60
Minnesota, Wisconsin, West Virginia	6.03	308	(2)	(2)	(2)	(2)	62	1,618	101	3,721	47
Ohio	6.04	739	(2)	(2)	(2)	(2)	162	6,309	542	17,357	55
Pennsylvania	2.83	622	(2)	(2)	279	10,766	78	1,951	183	6,250	206
Undistributed	--	--	116	1,955	439	9,822	--	--	--	--	--
Total 1975 [5]	5.21	4,281	257	4,413	1,202	36,900	715	20,615	1,953	62,897	1,035
Merchant plants	7.06	439	108	1,874	--	--	156	3,814	195	8,401	223
Furnace plants	5.06	3,842	149	2,539	1,202	36,900	559	16,801	1,758	54,496	812
Total 1974	5.73	5,094	204	2,751	1,470	20,248	971	14,461	2,310	41,192	879

[1] Calculated by dividing production by coal carbonized at plants actually recovering breeze.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Included with Indiana to avoid disclosing individual company confidential data.
[4] Included with Michigan to avoid disclosing individual company confidential data.
[5] Data may not add to totals shown because of independent rounding.

NOTE.—No recovery from beehive coke production was recorded in 1974–75.

Table 10.—Oven- and beehive-coke breeze used and sold in the United States, by use
(Thousand short tons)

Year	Used by producers: In steam plants	Used by producers: In agglomerating plants	Used by producers: For other industrial use	Sold	Average value per ton
1971	309	1,582	650	1,879	$10.80
1972	265	1,305	704	[1] 2,113	10.59
1973	234	1,689	917	[1] 2,165	10.39
1974	204	1,470	971	2,310	17.83
1975	257	1,202	715	1,953	32.21

[1] Does not include beehive-coke breeze sold (to avoid disclosing individual company confidential data).

Table 11.—Apparent consumption of coke in the United States
(Thousand short tons)

Year	Total production	Imports	Exports	Net change in stocks	Apparent consumption [1]	Consumption: In iron furnaces [2]: Quantity	Consumption: In iron furnaces [2]: Percent	Consumption: All other purposes: Quantity	Consumption: All other purposes: Percent
1971	57,436	174	1,509	−588	56,689	51,498	90.8	5,191	9.2
1972	60,507	185	1,232	−586	60,046	54,607	90.9	5,439	9.1
1973	64,325	1,078	1,395	−1,757	r 65,765	60,720	92.3	r 5,045	7.7
1974	61,581	3,540	1,278	−249	64,092	58,441	91.2	5,651	8.8
1975	57,207	1,819	1,273	+4,066	53,687	48,817	90.9	4,870	9.1

r Revised.
[1] Production plus imports, minus exports, plus or minus net change in stocks.
[2] American Iron and Steel Institute; figures include coke consumed in manufacturing ferroalloys.

Table 12.—Coke and coking coal consumed per short ton of pig iron and ferroalloys produced in the United States

Year	Coke per short ton of pig iron and ferroalloys [1] (pounds)	Yield of coke from coal (percent)	Coking coal per short ton of pig iron and ferroalloys (pounds, calculated)
1971	1,260.8	69.0	1,827.2
1972	1,221.6	69.0	1,767.9
1973	1,200.0	68.4	1,754.4
1974	1,218.7	r 68.4	r 1,782.8
1975	1,221.6	68.4	1,786.0

r Revised.
[1] American Iron and Steel Institute; consumption of pig iron only, excluding furnace making ferroalloys, was 1,254, 1971; 1,216.2, 1972; 1,193.8, 1973, and not available 1974 and 1975.

Table 13.—Oven coke produced in the United States, used by producers, and sold in 1975, by State
(Thousand short tons and thousand dollars)

State	Produced (quantity)	Used by producing companies: In blast furnaces: Quantity	In blast furnaces: Value	For other purposes[1]: Quantity	For other purposes[1]: Value	Commercial sales: To blast furnace plants: Quantity	To blast furnace plants: Value
Alabama	4,690	2,525	215,022	112	12,791	814	58,305
California, Colorado, Utah	2,996	2,738	186,370	(2)	(2)	--	--
Illinois	1,924	1,764	129,214	(2)	(2)	(2)	(2)
Indiana	9,246	8,406	739,284	(2)	(2)	(2)	(2)
Kentucky, Missouri, Tennessee, Texas	1,748	(2)	(2)	(2)	(2)	(2)	(2)
Maryland and New York	5,298	4,705	459,566	(2)	(2)	(2)	(2)
Michigan	3,243	(2)	(2)	(2)	(2)	(2)	(2)
Minnesota, West Virginia, Wisconsin	3,488	2,773	198,449	--	--	70	4,431
Ohio	8,467	6,999	542,219	(2)	(2)	529	37,760
Pennsylvania	15,395	13,016	1,144,130	28	2,190	87	7,440
Undistributed	--	3,307	270,789	271	28,331	1,181	89,635
Total 1975[3]	56,494	46,233	3,885,045	411	43,311	2,682	197,572
At merchant plants	4,716	--	--	180	19,847	1,649	118,769
At furnace plants	51,778	46,233	3,885,045	232	23,464	1,032	78,803
Total 1974	60,737	53,567	4,002,393	581	41,417	2,820	150,247

State	Commercial sales—Continued: To foundries: Quantity	To foundries: Value	To other industrial plants[4]: Quantity	To other industrial plants[4]: Value	Total: Quantity	Total: Value
Alabama	(2)	(2)	(2)	(2)	1,635	141,979
California, Colorado, Utah	(2)	(2)	--	--	(2)	(2)
Illinois	--	--	--	--	(2)	(2)
Indiana	(2)	(2)	(2)	(2)	480	50,650
Kentucky, Missouri, Tennessee, Texas	(2)	(2)	(2)	(2)	1,148	84,385
Maryland and New York	(2)	(2)	(2)	(2)	236	21,817
Michigan	(2)	(2)	(2)	(2)	434	43,667
Minnesota, West Virginia, Wisconsin	(2)	(2)	98	7,699	418	40,248
Ohio	203	21,253	96	7,216	830	66,229
Pennsylvania	322	35,255	189	15,049	599	57,745
Undistributed	1,867	198,281	337	25,647	16	1,251
Total 1975[3]	2,392	254,789	722	55,611	5,796	507,972
At merchant plants	2,193	232,481	443	34,744	4,285	385,994
At furnace plants	200	22,309	279	20,867	1,511	121,979
Total 1974	3,110	245,431	908	53,873	6,838	449,551

[1] Comprises 220,000 tons valued at $27,045,000 used in foundries; 191,000 tons valued at $16,266,000 for other purposes.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Data may not add to totals shown because of independent rounding.
[4] Includes coke used "For residential heating."

Table 14.—Production and sales of beehive coke in the United States in 1975
(Thousand short tons and thousand dollars)

State	Produced (quantity)	Commercial sales: To blast furnace plants		To foundries		To other industrial plants		For residential heating		Total	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Pennsylvania, Virginia, West Virginia:											
1975	713	708	45,959	--	--	(1)	(1)	--	--	708	45,959
1974 [2]	845	845	37,196	--	--	--	--	--	--	845	37,196

[1] Included with beehive coke sold "to blast furnace plants" to avoid disclosing individual company confidential data.
[2] Does not include West Virginia.

Table 15.—Distribution of oven and beehive coke and breeze in 1975 [1]

(Thousand short tons)

Consuming State	Coke				Breeze
	To blast furnace plants	To foundries	To other industrial plants [2]	Total [3]	
Alabama	2,659	315	47	3,021	243
Arizona	--	(4)	2	2	--
Arkansas	--	1	(4)	1	(4)
California	1,068	29	38	1,135	142
Colorado	729	8	24	761	69
Connecticut	--	6	--	6	--
Florida	--	1	4	5	13
Georgia	--	6	5	11	(4)
Idaho	--	(4)	11	11	--
Illinois	2,954	148	19	3,122	334
Indiana	8,838	127	28	8,993	784
Iowa	--	65	--	65	--
Kansas	--	10	(4)	11	--
Kentucky	1,024	32	22	1,078	61
Louisiana	--	1	13	14	1
Maine	--	(4)	--	(4)	--
Maryland	2,361	6	2	2,370	240
Massachusetts	--	10	--	10	--
Michigan	4,374	536	20	4,931	240
Minnesota	3	13	23	39	26
Mississippi	--	(4)	1	2	3
Missouri	--	33	80	112	18
Montana	--	--	4	4	14
Nebraska	--	2	--	2	--
New Jersey	--	39	28	66	10
New Mexico	--	--	(4)	(4)	--
New York	2,257	106	16	2,379	238
North Carolina	--	7	3	10	5
North Dakota	--	--	9	9	--
Ohio	8,348	384	104	8,836	552
Oklahoma	--	1	--	1	(4)
Oregon	--	(4)	8	8	12
Pennsylvania	10,757	178	115	11,050	568
Rhode Island	--	2	--	2	--
South Carolina	--	4	21	24	4
Tennessee	16	64	30	110	89
Texas	781	86	110	977	59
Utah	942	11	51	1,004	48
Virginia	--	70	--	70	130
Washington	--	5	--	5	--
West Virginia	2,442	--	35	2,477	177
Wisconsin	--	120	3	123	13
Wyoming	--	--	4	4	--
Total [3]	49,554	2,428	880	52,862	4,095
Exported	67	184	35	286	32
Grand total	49,621	2,612	915	53,148	4,127

[1] Based on reports from producers showing destination and principal end-use of coke used and sold. Does not include imported coke, which totaled 1,819,000 tons in 1975.
[2] Includes coke used "For residential heating."
[3] Data may not add to totals shown because of independent rounding.
[4] Less than 500 short tons.

Table 16.—Producers' stocks of coke and breeze in the United States on December 31, 1975, by State

(Thousand short tons)

State	Coke				Breeze
	Blast furnace	Foundry	Residential heating and other	Total [1]	
Oven coke:					
Alabama	455	14	1	470	32
California, Colorado, Utah	276	--	--	276	47
Illinois	287	--	--	287	45
Indiana	516	18	12	546	342
Kentucky, Missouri, Tennessee, Texas	20	7	11	38	39
Maryland and New York	291	20	([2])	311	161
Michigan	64	3	([2])	67	60
Minnesota and Wisconsin	214	29	2	245	41
Ohio	638	23	14	675	55
Pennsylvania	1,862	73	38	1,973	206
West Virginia	107	--	--	107	5
Total 1975 [1]	4,729	188	78	4,996	1,035
At merchant plants	49	168	61	278	223
At furnace plants	4,680	20	17	4,718	812
Total 1974	897	27	12	935	879
Beehive coke:					
Pennsylvania	5	--	--	5	--

[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.

Table 17.—Producers' month-end stocks of oven coke in the United States

(Thousand short tons)

Month	At merchant plants		At furnace plants		Total [1]	
	1974	1975	1974	1975	1974	1975
January	72	29	1,053	1,025	1,125	1,054
February	69	43	1,070	1,219	1,139	1,262
March	63	70	1,100	1,372	1,163	1,442
April	53	99	1,130	1,634	1,183	1,733
May	46	131	1,193	2,131	1,238	2,261
June	37	148	1,205	2,741	1,243	2,889
July	30	199	1,116	3,323	1,146	3,522
August	31	213	1,167	3,654	1,197	3,867
September	28	203	1,293	3,618	1,321	3,821
October	29	209	1,269	3,899	1,298	4,108
November	31	231	1,033	4,291	1,064	4,522
December	25	278	910	4,718	935	5,001

[1] Data may not add to totals shown because of independent rounding.

Table 18.—Average receipts per short ton of coke sold (commercial sales) in the United States, by use

Year	To blast furnace plants	To foundries	To other industrial plants	For residential heating	Total
Oven coke:					
1971	$30.49	$47.98	$29.75	$21.46	$37.41
1972	30.64	51.16	36.43	([1])	40.70
1973	32.41	54.73	36.55	([1])	42.92
1974	53.28	78.92	59.33	([1])	65.74
1975	73.67	106.52	77.02	([1])	87.64
Beehive coke:					
1971	21.24	--	W	--	W
1972	22.01	--	W	--	W
1973	27.31	--	W	--	W
1974	44.02	--	--	--	44.02
1975	65.17	--	([2])	--	65.17

W Withheld to avoid disclosing individual company confidential data.
[1] Included with "To other industrial plants" to avoid disclosing individual company confidential data.
[2] Included with "To blast furnace plants" to avoid disclosing individual company confidential data.

Table 19.—Coke exported from the United States, by country and customs district

	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
COUNTRY						
Algeria	191	$14	--	--	58	$59
Australia	205	4	101	$26	--	--
Belgium-Luxembourg	84,714	1,723	52,723	1,507	86,548	3,620
Brazil	8,465	537	7,059	846	12,500	1,778
Canada	747,543	18,210	709,717	24,760	680,595	38,431
Dominican Republic	373	9	791	23	10	2
France	--	--	127	64	17,437	737
Germany, West	265,084	5,270	119,331	2,533	116,979	3,877
India	1,123	55	--	--	--	--
Iran	184	15	2,879	91	85	40
Iraq	--	--	--	--	1,894	900
Italy	--	--	6,405	184	235	6
Japan	32,338	611	4,539	304	1,058	1,054
Mexico	102,284	3,874	157,956	6,107	107,288	9,780
Netherlands	104,845	1,728	95,935	2,389	172,929	8,103
Norway	8,019	140	12,628	389	124	58
Panama	755	21	137	20	--	--
Peru	141	15	128	5	1,131	158
Singapore	52	2	1,760	155	126	61
South Africa, Republic of	759	16	586	156	--	--
Spain	23,821	405	92,864	3,487	20,522	924
Sweden	5,480	135	4,592	111	--	--
Taiwan	52	2	95	11	110	49
Turkey	--	--	--	--	1,801	859
United Kingdom	838	75	732	110	616	62
Venezuela	543	22	1,812	64	49,815	3,983
Yugoslavia	6,527	237	3,466	132	--	--
Other	644	18	1,318	90	1,045	191
Total	1,394,980	33,138	1,277,681	43,564	1,272,906	74,732
CUSTOMS DISTRICT						
Baltimore	107,709	2,609	30,777	801	90	17
Buffalo	424,922	11,236	366,858	13,223	233,939	17,304
Charleston, S.C	--	--	551	59	189	89
Chicago	10,052	111	71,902	2,033	57,323	1,823
Cleveland	78,190	635	12,040	146	9,500	285
Detroit	188,367	4,510	304,224	9,770	392,711	18,159
Duluth	65,022	773	11,851	255	15,217	440
El Paso	188	3	637	25	696	80
Great Falls	701	13	3,751	165	382	45
Houston	1,420	101	5,645	390	745	295
Laredo	100,856	3,829	154,657	5,982	105,853	9,619
Los Angeles	20,349	226	66,997	1,218	37,934	2,094
Miami	--	--	322	28	70	10
Mobile	42,056	938	1,086	48	53,141	4,448
New Orleans	41,459	1,067	17,119	1,075	26,054	2,985
New York City	378	10	5,046	121	970	56
Nogales	821	26	551	23	123	16
Norfolk	122,222	1,954	114,803	3,057	170,302	7,017
Ogdensburg	2,282	59	4,997	116	4,427	144
Pembina	17,332	933	24,988	1,065	12,860	1,365
Philadelphia	164,885	3,794	68,382	3,452	146,590	7,992
San Diego	522	17	2,111	77	616	65
San Francisco	--	--	--	--	19	3
Seattle	5,208	292	8,249	432	3,113	356
Other	39	2	137	3	42	25
Total	1,394,980	33,138	1,277,681	43,564	1,272,906	74,732

Table 20.—U.S. imports for consumption of coke, by country and customs district

	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity short tons)	Value (thousands)	Quantity (short tons)	Value thousands)
COUNTRY						
Australia	123	$2	--	--	--	--
Belgium-Luxembourg	--	--	661	$57	3,504	$369
Canada	289,618	9,099	194,731	7,932	148,386	10,366
Czechoslovakia	11,574	355	--	--	--	--
France	--	--	2,222	127	--	--
Germany, West	r 748,297	r 28,639	2,761,585	156,005	1,387,755	123,114
Hungary	3,190	108	--	--	--	--
Italy	31,945	1,271	7,953	572	42,890	5,005
Japan	--	--	4	(1)	9,071	722
Netherlands	--	--	62,917	r 5,883	99,706	10,110
New Zealand	--	--	8,342	613	--	--
Norway	--	--	55,516	3,860	--	--
South Africa, Republic of	--	--	34,222	937	59,319	2,374
Sweden	--	--	--	--	3,708	384
U.S.S.R	--	--	28,733	2,379	16,177	1,424
United Kingdom	9,203	459	383,440	14,800	48,465	2,620
Total	r 1,093,950	r 39,933	3,540,326	193,165	1,818,981	156,488
CUSTOMS DISTRICT						
Baltimore	225,368	9,749	739,434	35,203	348,267	29,128
Buffalo	45,746	1,543	13,098	696	48,312	2,259
Charleston, S.C	--	--	11,759	323	--	--
Chicago	76,045	2,795	357,555	22,299	126,434	13,011
Cleveland	--	--	84,142	5,694	7,588	391
Detroit	134,937	4,592	329,724	25,800	382,183	30,917
Duluth	--	--	11,570	921	83	2
Great Falls	102,754	2,885	119,199	4,083	88,956	7,378
Honolulu	165	13	--	--	--	--
Milwaukee	--	--	6,180	808	--	--
Minneapolis	--	--	42	1	--	--
New Orleans	r 111,145	r 4,246	283,248	17,481	305,998	24,262
New York City	--	--	4	(1)	86,681	8,560
Ogdensburg	2,352	128	--	--	180	2
Pembina	--	--	2,040	101	--	--
Philadelphia	384,966	13,454	1,570,657	78,834	414,620	39,836
Portland, Maine	--	--	30	1	--	--
St. Albans	10,472	528	805	54	19	3
Seattle	--	--	--	--	589	17
Tampa	--	--	8,342	613	9,071	722
Wilmington, N.C	--	--	2,497	253	--	--
Total	r 1,093,950	r 39,933	3,540,326	193,165	1,818,981	156,488

r Revised.
[1] Less than ½ unit.

Table 21.—Coke: World production, by type and country

(Thousand short tons)

Kind of coke and country [1]	1973	1974	1975 p
METALLURGICAL COKE [2]			
North America:			
Canada [3] [4]	5,920	6,008	5,119
Mexico	r 2,112	2,228	2,268
United States	64,325	61,581	57,207
South America:			
Argentina e	490	250	190
Brazil	r 2,040	2,056	2,090
Chile	331	334	233
Colombia	r 595	39	39
Peru e	39	39	39
Europe:			
Austria [3]	1,894	1,911	1,771
Belgium	8,599	8,874	6,314
Czechoslovakia	r 10,103	10,258	e 11,970
Finland [4]	r 73	--	--
France [3]	13,095	12,874	12,114
Germany, East	2,046	2,016	e 1,950
Germany, West	37,475	38,494	38,379
Greece	441	410	470
Hungary	r 861	844	850
Italy	8,450	9,442	8,945
Netherlands [3]	2,927	2,959	2,954
Norway	r 357	345	287
Poland [5]	r 18,671	18,662	e 18,740
Portugal	246	178	e 176
Romania	1,456	2,019	e 1,980
Spain [6]	4,932	4,677	5,358
Sweden [3] [4]	588	530	e 510
U.S.S.R. [3]	89,729	91,096	e 91,100
United Kingdom	r 19,595	17,965	e 18,300
Yugoslavia	1,377	1,372	[8] 1,489
Africa:			
Egypt e	400	400	400
Rhodesia, Southern e	270	270	270
South Africa, Republic of	3,961	4,200	4,898
Asia:			
China, People's Republic of e	30,900	30,900	30,900
India [7]	9,809	e 10,100	e 10,100
Iran e	440	550	550
Japan	48,850	50,301	49,382
Korea, North e	2,400	2,400	2,400
Korea, Republic of	356	661	676
Taiwan	240	206	222
Turkey e	1,410	1,410	1,380
Oceania: Australia	5,451	5,637	e 5,730
Total metallurgical coke	r 403,254	404,898	398,152
GASHOUSE COKE [8]			
South America:			
Brazil	40	e 41	e 41
Chile	--	--	5
Uruguay	15	15	15
Europe:			
Denmark	91	e 91	e 91
France	--	665	502
Germany, West	1,705	1,702	1,378
Greece	11	e 11	e 11
Hungary	548	487	252
Ireland	41	41	37
Italy	(9)	--	--
Poland	1,361	1,242	e 1,430
Switzerland	110	44	e 44
United Kingdom	r 258	13	e 13
Africa:			
Egypt e	33	33	33
South Africa, Republic of	109	e 110	e 110
Asia:			
India	61	e 40	e 40
Japan	4,825	4,838	4,650
Taiwan	(9)	(9)	--
Turkey e	35	35	33
Oceania:			
Australia	(9)	(9)	e (9)
New Zealand	26	34	33
Total gashouse coke	9,269	9,442	8,718

See footnotes at end of table.

Table 21.—Coke: World production, by type and country—Continued
(Thousand short tons)

Kind of coke and country [1]	1973	1974	1975 [p]
ALL OTHER TYPES [10]			
Europe: Germany, East [11]	6,326	6,467	[e] 6,467
Asia: India	3,921	[e] 4,100	[e] 4,100
Total all other types	10,247	10,567	10,567
Grand total	[r] 422,770	424,907	417,437

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, Algeria, Australia, Malaysia, the People's Republic of China, Mexico, Norway, Romania and the U.S.S.R. have produced gashouse coke in previous years and may have continued production during the time period covered by this table. However, no official statistics are available, and information is inadequate to make reliable estimates of production levels. Except where otherwise noted, coke breeze has been excluded from this table.
[2] Coke production at high temperature in conventional carbonizing equipment (including slot and beehive coke ovens).
[3] Includes breeze.
[4] Includes relatively small amounts of gas coke.
[5] May include some gas coke.
[6] Includes relatively small amounts of low-temperature coke.
[7] Data are total of so-called hard coke production from collieries and coke plants (including those at steelworks).
[8] Includes coke produced at high temperatures in carbonizing equipment designed primarily for gas manufacture (horizontal and vertical coal-gas retorts). In addition to the countries listed, Canada and Finland produce gas coke. However, this figure is not reported separately and has been included with metallurgical coke.
[9] Less than ½ unit.
[10] Includes coke produced at low and medium temperatures, as well as that produced in unconventional equipment (chain-grate cokers). In addition to the countries listed, the U.S.S.R. may produce coke from brown coal, but output is not officially reported and no basis is available for reliably estimating output levels.
[11] Includes coke produced from lignite at high temperature.

Table 22.—Quantity, sulfur content, and value at ovens of coal carbonized in the United States in 1975, by State

State	Coal carbonized				Coal per ton of coke	
	Thousands short tons	Average sulfur content (percent)	Value: Total (thousands)	Value: Average	Short tons	Value
Oven coke:						
Alabama	6,755	0.9	$272,000	$40.27	1.44	$57.99
California, Colorado, Utah	4,796	.7	177,960	37.11	1.60	59.38
Illinois	3,087	1.0	122,849	39.80	1.60	63.68
Indiana	13,822	.8	653,143	47.25	1.49	70.40
Kentucky, Missouri, Tennessee, Texas	2,596	.9	111,279	42.87	1.49	63.88
Maryland and New York	7,512	.9	430,224	57.27	1.42	81.32
Michigan	4,497	.9	249,248	55.43	1.39	77.05
Minnesota and Wisconsin	1,071	1.0	51,799	48.37	1.37	66.27
Ohio	12,296	.9	517,948	42.12	1.45	61.07
Pennsylvania	22,004	1.0	895,402	40.69	1.43	58.19
West Virginia	4,037	1.2	163,845	40.59	1.49	60.48
Total 1975 [1]	82,472	.9	3,645,697	44.21	1.46	64.55
At merchant plants	6,490	.9	338,979	52.23	1.38	72.08
At furnace plants	75,982	.9	3,306,718	43.52	1.47	63.97
Total 1974	88,854	.9	3,242,455	36.49	1.46	53.28
Beehive coke:						
Pennsylvania, Virginia, West Virginia						
1975	1,128	--	W	W	1.58	W
1974	1,340	--	W	W	1.59	W

W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.

Table 23.—Bituminous coal carbonized in coke ovens in the United States, by month
(Thousand short tons)

Month	1974 Slot	1974 Beehive	1974 Total[1]	1975 Slot	1975 Beehive	1975 Total[1]
January	7,870	107	7,977	7,191	112	7,303
February	7,205	102	7,307	6,923	108	7,032
March	7,553	107	7,660	7,772	108	7,880
April	7,659	111	7,770	7,327	100	7,427
May	7,796	108	7,904	7,193	89	7,283
June	7,576	106	7,682	6,919	81	7,000
July	7,671	99	7,770	6,547	91	6,639
August	7,588	128	7,716	6,470	94	6,564
September	7,402	132	7,534	6,190	97	6,287
October	7,572	139	7,711	6,565	94	6,659
November	6,482	99	6,581	6,396	89	6,485
December	6,036	99	6,136	6,654	62	6,716
Total[1]	88,410	1,340	89,750	82,147	1,128	83,274

[1] Data may not add to totals shown because of independent rounding.

Table 24.—Anthracite carbonized at oven-coke plants in the United States, by month[1]
(Thousand short tons)

Month	1974	1975
January	[2] 41	30
February	[2] 36	29
March	[2] 39	33
April	[2] 37	27
May	[2] 37	25
June	[2] 34	22
July	34	26
August	41	26
September	34	26
October	36	29
November	35	27
December	40	28
Total	444	[3] 326

[1] Includes petrocoke.
[2] Also includes breeze.
[3] Data do not add to total shown because of independent rounding.

Table 25.—Average value per short ton of coal carbonized at oven-coke plants in the United States, by State

State	1974	1975
Alabama	$33.94	$40.27
California, Colorado, Utah	34.65	37.11
Illinois	32.83	39.80
Indiana	37.03	47.25
Kentucky, Missouri, Tennessee, Texas	32.83	42.87
Maryland and New York	42.70	57.27
Michigan	44.29	55.43
Minnesota and Wisconsin	38.68	48.37
Ohio	34.89	42.12
Pennsylvania	36.44	40.69
West Virginia	30.45	40.59
Average	36.49	44.21
Value of coal per ton of coke	[r] 53.39	64.55

[r] Revised.

Table 26.—Average volatile content of bituminous coal carbonized by oven-coke plants in the United States

Year	High: Quantity (thousand short tons)	High: Volatile content (percent)	Medium: Quantity (thousand short tons)	Medium: Volatile content (percent)	Low: Quantity (thousand short tons)	Low: Volatile content (percent)	Total: Quantity (thousand short tons)	Total: Volatile content (percent)
1971	53,542	35.1	12,085	25.2	15,904	18.3	81,531	30.4
1972	60,536	34.7	8,754	26.4	16,923	16.8	86,213	30.3
1973	64,486	34.6	10,090	26.6	17,762	16.2	92,338	30.2
1974	61,344	34.8	10,763	25.6	16,303	17.9	88,410	30.6
1975	57,488	34.8	9,619	25.7	15,040	18.3	82,147	30.7

Table 27.—Coal received by oven-coke plants in the United States in 1975, by consuming State and volatile content[1]

(Thousand short tons)

Consuming State	High volatile		Medium volatile		Low volatile		Total coal receipts[2]
	Quantity	Percent of total	Quantity	Percent of total	Quantity	Percent of total	
Alabama	2,417	35.4	3,473	50.9	933	13.7	6,823
California, Colorado, Utah	3,740	76.3	622	12.7	542	11.0	4,904
Illinois	2,401	78.1	10	.3	664	21.6	3,074
Indiana	8,147	57.6	2,100	14.8	3,901	27.6	14,147
Kentucky, Missouri, Tennessee, Texas	1,891	69.5	291	10.7	540	19.8	2,722
Maryland and New York	4,448	62.0	992	13.8	1,739	24.2	7,179
Michigan	3,200	61.7	578	11.1	1,410	27.2	5,187
Minnesota and Wisconsin	544	45.6	216	18.1	431	36.2	1,192
Ohio	9,314	77.2	545	4.5	2,204	18.3	12,063
Pennsylvania	16,883	73.0	2,024	8.7	4,234	18.3	23,142
West Virginia	3,452	77.5	89	2.0	911	20.5	4,453
Total 1975[2]	56,437	66.5	10,939	12.9	17,509	20.6	84,886
At merchant plants	2,599	40.1	1,015	15.6	2,874	44.3	6,487
At furnace plants	53,838	68.7	9,925	12.7	14,637	18.7	78,399
Total 1974	60,397	68.5	10,140	11.5	17,578	r 19.9	88,115

r Revised.
[1] Volatile matter on moisture-free basis: High volatile, over 31%; medium volatile, 22% to 31%; and low-volatile, 14% to 22%.
[2] Data may not add to totals shown because of independent rounding.

Table 28.—Origin of coal received by oven-coke plants in the United States in 1975, by producing county and volatile content[1]

(Thousand short tons)

Origin of coal	Volatile content: High	Medium	Low	Total[2]
Alabama:				
Bibb	403	--	--	403
Blount	51	27	--	77
De Kalb	--	--	108	108
Etowah	17	--	--	17
Fayette	39	--	--	39
Jefferson	1,082	3,370	--	4,452
Marion	44	--	--	44
Tuscaloosa	--	131	--	131
Walker	565	71	--	636
Arkansas: Sebastian	--	--	214	214
Colorado:				
Delta	38	--	--	38
Gunnison	963	--	--	963
Las Animas	634	--	--	634
Pitkin	--	410	538	948
Illinois:				
Franklin	1,539	--	--	1,539
Jefferson	1,948	--	--	1,948
Saline	117	--	--	117
Kentucky:				
Bell	10	--	--	10
Clay	28	--	--	28
Floyd	1,830	--	--	1,830
Greenup	32	--	--	32
Harlan	2,979	--	--	2,979
Knox	477	--	--	477
Letcher	2,366	--	--	2,366
Perry	155	--	--	155
Pike	4,270	--	--	4,270
Whitley	12	--	--	12
New Mexico: Colfax	742	--	--	742
Ohio: Jackson	12	--	--	12
Oklahoma:				
Haskell	--	239	--	239
Le Flore	--	--	70	70
Pittsburg	116	--	--	116
Rogers	244	--	--	244

See footnotes at end of table.

Table 28.—Origin of coal received by oven-coke plants in the United States in 1975, by producing county and volatile content [1]—Continued

(Thousand short tons)

Origin of coal	Volatile content High	Volatile content Medium	Volatile content Low	Total [2]
Pennsylvania:				
Anthracite	--	--	358	358
Bituminous:				
Allegheny	1,977	--	--	1,977
Armstrong	114	--	--	114
Butler	202	--	--	202
Cambria	--	2,091	2,175	4,266
Clearfield	--	23	191	214
Fayette	201	--	5	205
Greene	5,533	--	--	5,533
Indiana	1	--	--	1
Jefferson	4	--	--	4
Lycoming	--	--	157	157
Mercer	29	--	5	34
Somerset	--	--	1,293	1,293
Washington	9,967	--	--	9,967
Westmoreland	1,068	84	--	1,152
Tennessee:				
Claiborne	113	--	--	113
Morgan	--	79	--	79
Utah: Carbon	1,784	--	--	1,784
Virginia:				
Buchanan	108	719	2,645	3,471
Dickenson	325	--	--	325
Russell	--	55	--	55
Tazewell	--	70	--	70
Wise	579	--	--	579
West Virginia:				
Barbour	108	--	--	108
Boone	1,786	--	--	1,786
Clay	43	--	--	43
Fayette	1,835	70	372	2,277
Gilmer	23	--	--	23
Grant	--	40	--	40
Greenbrier	--	47	--	47
Harrison	123	--	--	123
Kanawha	1,858	--	--	1,858
Logan	5,117	319	--	5,436
McDowell	--	1,380	5,062	6,442
Marion	682	--	--	682
Mercer	--	--	552	552
Mineral	--	--	20	20
Mingo	1,189	--	--	1,189
Monongalia	22	--	--	22
Nicholas	271	1,090	--	1,361
Preston	--	81	--	81
Raleigh	--	387	1,337	1,723
Randolph	3	1	--	3
Upshur	156	--	--	156
Wayne	12	--	--	12
Webster	--	28	--	28
Wyoming	493	95	2,307	2,895
Canada: Alberta	--	--	54	54
Germany, West: Ruhr	--	33	48	82
Total [2]	56,437	10,939	17,509	84,886

[1] Volatile matter on moisture-free basis; high volatile, over 31%; medium volatile, 22% to 31%; and low volatile, 14% to 22%.

[2] Data may not add to totals shown because of independent rounding.

Table 29.—Origin of coal received by oven-coke plants in the United States in 1975, by State

(Thousand short tons)

Consuming State	Producing State: Alabama	Arkansas	Colorado	Illinois	Kentucky	Maryland	New Mexico	Ohio	Oklahoma
Alabama	5,438	--	--	--	432	--	--	--	--
California, Colorado, Utah	--	--	2,542	--	--	--	742	--	212
Illinois	--	209	--	1,038	1,154	--	--	--	22
Indiana	179	--	--	2,567	3,008	--	--	--	--
Kentucky, Missouri, Tennessee, Texas	222	2	--	--	35	--	--	--	421
Maryland and New York	--	--	--	--	1,066	--	--	--	--
Michigan	41	--	38	--	1,319	--	--	--	--
Minnesota and Wisconsin	7	--	--	--	230	--	--	12	13
Ohio	19	--	2	--	1,973	--	--	--	--
Pennsylvania	--	--	--	--	2,443	--	--	--	--
West Virginia	--	2	--	--	496	--	--	--	--
Total 1975[1]	5,906	214	2,582	3,605	12,159	--	742	12	669
At merchant plants	472	2	--	--	178	--	--	--	13
At furnace plants	5,435	211	2,582	3,605	11,980	--	742	12	655
Total 1974	6,442	178	2,438	4,036	14,564	7	925	41	343

Consuming State	Producing State—Continued: Pennsylvania	Tennessee	Utah	Virginia	West Virginia	Canada	Germany	Total[1]
Alabama	99	44	--	366	442	--	--	6,823
California, Colorado, Utah	4	--	1,404	--	--	--	--	4,904
Illinois	6	--	--	92	554	--	--	3,074
Indiana	2,129	--	--	1,219	5,045	--	--	14,147
Kentucky, Missouri, Tennessee, Texas	44	--	--	196	1,803	--	--	2,722
Maryland and New York	3,127	--	--	588	2,295	54	48	7,179
Michigan	193	17	172	297	3,110	--	--	5,187
Minnesota and Wisconsin	244	49	208	152	276	--	--	1,192
Ohio	3,998	79	--	785	5,207	--	--	12,063
Pennsylvania	13,177	--	--	703	6,785	--	33	23,142
West Virginia	2,456	4	--	104	1,391	--	--	4,453
Total 1975[1]	25,477	192	1,784	4,501	26,908	54	82	84,886
At merchant plants	373	(2)	7	1,302	4,141	--	--	6,487
At furnace plants	25,104	192	1,777	3,199	22,767	54	82	78,399
Total 1974	24,864	168	1,863	4,557	26,704	248	737	88,115

[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.

Table 30.—Quantity and percentage of captive coal received by oven-coke plants in the United States

(Thousand short tons)

Year	At merchant plants: Total coal received	Captive coal: Quantity	Captive coal: Percent	At furnace plants: Total coal received	Captive coal: Quantity	Captive coal: Percent	Total[1]: Total coal received	Captive coal: Quantity	Captive coal: Percent
1971	5,284	2,235	42.3	74,113	44,319	59.8	79,397	46,554	58.6
1972	7,804	2,235	29.8	80,158	45,354	56.7	87,962	47,679	r 54.2
1973	6,820	1,723	25.3	83,943	47,412	56.5	90,763	49,134	54.1
1974	6,877	1,520	22.1	81,239	44,116	54.3	88,115	45,637	51.8
1975	6,487	1,202	18.5	78,399	44,303	56.5	84,886	45,505	53.6

r Revised.
[1] Data may not add to totals shown because of independent rounding.

Table 31.—Month-end stocks of bituminous coal at oven-coke plants in the United States

(Thousand short tons)

Month	1974[1]	1975
January	6,269	7,140
February	6,104	8,010
March	6,255	8,665
April	6,662	8,980
May	7,508	9,603
June	7,395	10,009
July	6,506	8,126
August	6,720	7,340
September	7,115	7,003
October	8,345	7,729
November	7,249	8,468
December	6,037	8,671

[1] All months revised except January and December.

Table 32.—Month-end stocks of anthracite coal at oven-coke plants in the United States[1]

(Thousand short tons)

Month	1974	1975
January	[2] 85	171
February	[2] 76	165
March	[2] 70	159
April	[2] 65	145
May	[2] 89	135
June	[2] 78	131
July	78	125
August	119	127
September	151	128
October	164	129
November	170	133
December	172	126

[1] Includes petrocoke.
[2] Also includes breeze.

Table 33.—Coal-chemical materials, exclusive of breeze, produced at oven-coke plants in the United States in 1975 [1]

Product	Produced	Sold: Quantity	Sold: Value: Total (thousands)	Sold: Value: Average per unit	Stocks, Dec. 31
Tar, crude ---- thousand gallons --	645,537	284,841	$98,898	$0.347	52,690
Tar derivatives:					
Sodium phenolate or carbolate - do ----	2,553	2,374	323	.136	70
Crude chemical oil (tar acid oil) do ----	5,294	5,333	2,088	.392	95
Pitch of tar: [2]					
Soft ---- thousand short tons --	466	200	18,634	93.170	10
Hard ---- do ----	(2)	(2)	(2)	(2)	(2)
Other tar derivatives [3] ----	XX	XX	13,309	XX	XX
Ammonia products:					
Sulfate ---- thousand short tons --	511	410	32,010	78.076	122
Liquor (NH_3 content) ---- do ----	6	8	742	92.750	2
Diammonium phosphate ---- do ----	(4)	(4)	(4)	(4)	(4)
Total ---- do ----	XX	XX	32,753	XX	XX
Sulfate equivalent of all forms do ----	534	439	XX	XX	129
NH_3 equivalent of all forms -- do ----	138	113	XX	XX	33
Gas:					
Used under boilers, etc. million cubic feet --	[5] 895,279	108,041	57,162	.529	--
Used in steel or allied plants - do ----		395,733	224,454	.567	--
Distributed through city mains do ----		10,122	5,244	.518	--
Sold for industrial use ---- do ----		13,322	5,834	.438	--
Total [6] ---- do ----	[5] 895,279	527,218	292,694	.555	--
Crude light oil ---- thousand gallons --	[7] 194,814	99,005	44,234	.447	7,574
Light oil derivatives:					
Benzene:					
Specification grades (1°, 2°, 90%) ---- do ----	65,050	66,283	49,724	.750	2,217
Other industrial grades -- do ----	(8)	(8)	(8)	(8)	(8)
Toluene (all grades) ---- do ----	9,841	10,455	5,539	.530	510
Xylene (all grades) ---- do ----	1,884	1,958	1,083	.553	159
Solvent naphtha (all grades) - do ----	2,045	1,947	652	.335	191
Other light oil derivatives --- do ----	3,488	1,241	421	.339	273
Total [6] ---- do ----	82,308	81,885	57,419	.701	3,349
Intermediate light oil ---- do ----	4,943	1,634	575	.352	219
Grand total [6] ----	XX	XX	560,927	XX	XX

XX Not applicable.
[1] Includes products of tar distillation conducted by oven-coke operators under the same corporate names.
[2] Soft—water-softening point less than 100° to 160° F; hard—oven 160° F. Figures on soft pitch include hard pitch to avoid disclosing individual company confidential data.
[3] Creosote oil, cresols, cresylic acid, naphthalene, phenol, refined tar, tar paint.
[4] Included with sulfate to avoid disclosing individual company confidential data.
[5] Includes gas used for heating ovens and gas wasted.
[6] Data may not add to totals shown because of independent rounding.
[7] Includes 95,178,000 gallons refined by coke-oven operators to make derived products shown.
[8] Included with "Specification grades" to avoid disclosing individual company confidential data.

Table 34.—Coal equivalent of the thermal materials, except coke, produced at oven-coke plants in the United States

Year	Materials produced: Coke breeze (thousand short tons)	Surplus gas (billion cubic feet)	Tar (thousand gallons)	Light oil (thousand gallons)	Estimated equivalent in heating value [1] (billion Btu): Coke breeze	Surplus gas	Tar	Light oil	Total	Coal [2] equivalent (thousand short tons)
1971	4,048	507	679,377	201,626	80,960	278,850	101,907	26,211	487,928	18,623
1972	4,261	534	747,186	214,201	85,220	293,700	112,078	27,846	518,844	19,803
1973	4,902	596	732,455	226,110	98,040	327,800	109,868	29,394	565,102	21,569
1974	5,094	574	677,447	217,416	101,880	315,700	101,617	28,264	547,461	20,896
1975	4,281	527	645,537	194,814	85,620	289,850	96,831	25,326	497,627	18,993

[1] Breeze, 10,000 Btu per pound; gas 550 Btu per cubic foot; tar, 150,000 Btu per gallon; light oil, 130,000 Btu per gallon.
[2] At 26,200,000 Btu per short ton of coal.

Table 35.—Average value of coal-chemical materials used or sold and of coke and breeze per short ton of coal carbonized in the United States

	1971	1972	1973	1974	1975
Ammonia products	$0.136	$0.141	$0.177	$0.418	$0.397
Light oil and its derivatives	.365	.350	.418	1.276	1.233
Surplus gas used or sold	1.640	1.660	2.052	3.366	3.549
Tar and its derivatives (including naphthalene):					
Tar burned by producers [1]	.341	.366	.572	.753	.945
Sold	.721	.720	.611	1.528	1.616
Total	3.203	3.237	3.830	[2] 7.342	7.740
Coke produced [3]	21.135	22.978	26.315	50.005	57.843
Breeze produced	.534	.533	.558	1.022	1.414
Grand total	24.872	26.748	30.703	58.369	66.997

[1] Includes pitch-of-tar.
[2] Data do not add to total shown because of independent rounding.
[3] Average value of coke used or sold.

Table 36.—Percentage of coal costs recovered from the recovery of coal-chemical materials in the United States

	1971	1972	1973	1974	1975
Product:					
Ammonia products	1.1	1.0	1.0	1.2	1.0
Light oil and its derivatives	3.8	3.2	2.3	3.5	3.1
Surplus gas used or sold	11.7	10.6	11.2	9.2	8.0
Tar and its derivatives used or sold (including naphthalene)	8.0	8.0	6.5	6.3	6.2
Total	24.6	22.8	21.0	20.2	18.3
Value of coal per short ton	$14.00	$15.74	$18.32	$36.49	$44.21

Table 37.—Production and disposal of coke-oven gas in the United States in 1975, by State
(Million cubic feet)

State	Produced		Used in heating ovens	Surplus used or sold			Wasted
					Value		
	Total	Thousand cubic feet per ton of coal		Quantity	Thousands	Average per thousand cubic feet	
Alabama	68,457	10.13	33,473	33,894	$10,415	$0.307	1,090
California, Colorado, Utah	65,826	13.73	18,664	46,868	21,406	.457	294
Illinois	30,794	9.98	14,335	13,649	6,592	.483	2,810
Indiana	149,865	10.84	64,558	84,229	47,552	.565	1,080
Kentucky, Missouri, Tennessee, Texas	25,310	9.75	12,252	10,937	4,571	.418	2,121
Maryland and New York	79,185	10.54	29,613	48,340	37,887	.784	1,233
Michigan	46,736	10.39	8,424	36,913	22,042	.597	1,398
Minnesota and Wisconsin	11,234	10.49	5,488	5,087	1,846	.363	659
Ohio	131,967	10.73	51,923	78,582	45,163	.575	1,462
Pennsylvania	236,831	10.76	103,551	131,976	70,731	.536	1,304
West Virginia	49,076	12.16	12,290	36,764	24,489	.666	22
Total 1975 [1]	895,279	10.86	354,569	527,238	292,694	.555	13,472
At merchant plants	61,497	9.48	29,798	28,708	11,409	.397	2,992
At furnace plants	833,782	10.97	324,772	498,530	281,285	.564	10,480
Total 1974	967,244	10.89	380,923	574,032	299,102	.521	12,290

[1] Data may not add to totals shown because of independent rounding.

Table 38.—Surplus coke-oven gas used by producers in the United States and sold in 1975, by State

(Million cubic feet)

State	Used by producers: Under boilers, etc.: Quantity	Under boilers, etc.: Value: Thousands	Under boilers, etc.: Value: Average per thousand cubic feet	In steel or allied plants: Quantity	In steel or allied plants: Value: Thousands	In steel or allied plants: Value: Average per thousand cubic feet
Alabama	9,688	$4,113	$0.425	20,904	$5,352	$0.256
California, Colorado, Utah	(1)	(1)	(1)	(1)	(1)	(1)
Illinois	3,761	1,660	.441	9,129	4,654	.510
Indiana	13,617	9,059	.665	68,109	36,948	.542
Kentucky, Missouri, Tennessee, Texas	6,175	2,188	.354	(1)	(1)	(1)
Maryland and New York	1,189	502	.422	41,830	35,436	.847
Michigan	(1)	(1)	(1)	(1)	(1)	(1)
Minnesota and Wisconsin	4,515	1,714	.380	--	--	--
Ohio	12,741	6,492	.510	61,405	35,702	.581
Pennsylvania	13,106	6,634	.506	117,877	63,580	.539
West Virginia	(1)	(1)	(1)	(1)	(1)	(1)
Undistributed	43,249	24,799	.573	76,480	42,781	.559
Total 1975 [2]	108,041	57,162	.529	395,733	224,454	.567
At merchant plants	13,319	4,704	.353	(3)	(3)	(3)
At furnace plants	94,722	52,458	.554	395,733	224,454	.567
Total 1974	116,029	44,875	.387	396,671	212,177	.535

State	Sold: Distributed through city mains: Quantity	Distributed through city mains: Value: Thousands	Distributed through city mains: Value: Average per thousand cubic feet	For industrial use: Quantity	For industrial use: Value: Thousands	For industrial use: Value: Average per thousand cubic feet
Alabama	--	--	--	(1)	(1)	(1)
California, Colorado, Utah	--	--	--	--	--	--
Illinois	--	--	--	(1)	(1)	(1)
Indiana	(1)	(1)	(1)	(1)	(1)	(1)
Kentucky, Missouri, Tennessee, Texas	--	--	--	(1)	(1)	(1)
Maryland and New York	(1)	(1)	(1)	--	--	--
Michigan	--	--	--	(1)	(1)	(1)
Minnesota and Wisconsin	--	--	--	(1)	(1)	(1)
Ohio	(1)	(1)	(1)	(1)	(1)	(1)
Pennsylvania	(1)	(1)	(1)	(1)	(1)	(1)
West Virginia	--	--	--	(1)	(1)	(1)
Undistributed	10,122	$5,244	$0.518	13,322	$5,834	$0.438
Total 1975 [2]	10,122	5,244	.518	13,322	5,834	.438
At merchant plants	2,877	1,553	.540	11,228	4,549	.405
At furnace plants	7,245	3,692	.510	2,094	1,286	.614
Total 1974	11,753	5,040	.429	49,578	37,009	.746

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Data may not add to totals shown because of independent rounding.
[3] Included with furnace plants to avoid disclosing individual company confidential data.

Table 39.—Coke-oven gas and other gases used in heating coke ovens in the United States in 1975, by State[1]

(Million cubic feet)

State	Coke-oven gas	Blast furnace gas	Natural gas	Other	Total coke-oven gas equivalent[2]
Alabama	33,473	--	--	--	33,473
California, Colorado, Utah	18,664	5,680	--	--	24,344
Illinois	14,335	13	--	--	14,348
Indiana	64,557	3,395	665	--	68,617
Kentucky, Missouri, Tennessee, Texas	12,251	50	17	--	12,319
Maryland and New York	29,613	4,684	--	--	34,297
Michigan	8,424	12,054	--	--	20,479
Minnesota and Wisconsin	5,488	--	--	14	5,502
Ohio	51,923	2,423	--	3,023	57,369
Pennsylvania	103,551	1,100	--	--	104,651
West Virginia	12,290	6,042	--	--	18,332
Total 1975[2]	354,569	35,442	683	3,037	393,731
At merchant plants	29,798	4,684	--	14	34,496
At furnace plants	324,772	30,758	683	3,023	359,235
Total 1974	380,923	32,609	2,118	--	415,650

[1] Adjusted to an equivalent of 550 Btu per cubic foot.
[2] Data may not add to totals shown because of independent rounding.

Table 40.—Coke-oven ammonia produced in the United States and sold in 1975, by State

(Thousand short tons and thousand dollars)

State	Active plants[1]	Produced: Sulfate equivalent	Produced: Pounds per ton of coal coked	Produced: As sulfate[2]	Produced: As liquor (NH_3 content)
Alabama	7	60	17.76	60	--
California, Colorado, Utah	3	36	15.01	36	--
Illinois	4	24	15.55	24	--
Indiana and Michigan	7	113	14.23	105	(3)
Kentucky, Minnesota, Tennessee, Texas	4	15	17.64	9	(3)
Maryland and New York	4	68	18.10	67	(4)
Ohio	11	91	15.43	82	(3)
Pennsylvania	8	97	17.16	97	--
West Virginia	3	30	14.86	30	--
Undistributed	--	--	--	--	6
1975[5]	51	534	15.98	511	6
At merchant plants	7	28	16.59	(6)	6
At furnace plants	44	505	15.93	511	(7)
1974	46	572	16.65	547	7

State	Sold: As sulfate: Quantity	Sold: As sulfate: Value	Sold: As liquor (NH_3 content): Quantity	Sold: As liquor (NH_3 content): Value	Stocks, Dec. 31: As sulfate	Stocks, Dec. 31: As liquor (NH_3 content)
Alabama	48	2,858	--	--	13	--
California, Colorado, Utah	37	1,522	--	--	(4)	--
Illinois	19	1,344	--	--	7	--
Indiana and Michigan	87	11,547	(3)	(3)	24	(3)
Kentucky, Minnesota, Tennessee, Texas	8	443	(3)	(3)	1	(3)
Maryland and New York	51	4,081	(3)	(3)	18	(3)
Ohio	65	4,078	(3)	(3)	18	(3)
Pennsylvania	70	4,794	--	--	33	--
West Virginia	24	1,345	--	--	7	--
Undistributed	--	--	8	742	--	2
1975[5]	410	32,010	8	742	122	2
At merchant plants	(6)	(6)	8	742	(6)	2
At furnace plants	410	32,010	(7)	(7)	122	(7)
1974	552	36,678	6	497	24	1

[1] Number of plants that recovered ammonia.
[2] Includes diammonium phosphate to avoid disclosing individual company confidential data.
[3] Included with "Undistributed" to avoid disclosing individual company confidential data.
[4] Less than 500 tons.
[5] Data may not add to totals shown because of independent rounding.
[6] Included with furnace plants to avoid disclosing individual company confidential data.
[7] Included with merchant plants to avoid disclosing individual company confidential data.

Table 41.—Coke-oven tar produced in the United States, used by producers, and sold in 1975, by State

(Thousand gallons)

State	Produced		Used by producers			Sold for refining into tar products			
	Total	Gallons per ton of coal coked	For refining or topping	As fuel	Otherwise	Quantity	Value: Thousands	Value: Average per gallon	Stocks Dec. 31
Alabama	43,785	6.48	(1)	(1)	--	26,832	$10,051	$0.375	3,424
California, Colorado, Utah	43,673	9.11	--	(1)	--	25,422	6,872	.270	3,286
Illinois	20,598	6.67	--	(1)	(1)	14,699	4,646	.316	2,939
Indiana	109,155	7.90	(1)	(1)	--	37,723	13,698	.363	3,799
Kentucky, Missouri, Tennessee, Texas	15,232	5.87	--	--	(1)	15,406	5,800	.376	471
Maryland and New York	57,103	7.60	--	33,014	--	23,548	8,286	.352	7,758
Michigan	32,737	7.28	--	--	--	33,666	11,365	.338	3,994
Minnesota and Wisconsin	6,293	5.88	--	--	(1)	(2)	(2)	(2)	(2)
Ohio	96,384	7.84	--	47,124	(1)	44,548	16,450	.369	4,944
Pennsylvania	181,333	8.24	(1)	39,803	2,489	39,423	14,657	.372	21,206
West Virginia	39,244	9.72	(1)	--	--	23,575	7,073	.300	868
Undistributed	--	--	178,147	42,171	2,475	--	--	--	--
Total 1975 [3]	645,537	7.83	178,147	162,112	4,964	284,841	98,898	.347	52,690
At merchant plants	35,372	5.45	(4)	(4)	--	31,546	12,579	.399	1,077
At furnace plants	610,165	8.03	178,147	162,112	4,964	253,295	86,319	.341	51,613
Total 1974	677,447	7.62	185,476	180,907	3,556	333,623	103,830	.311	[5] 37,218

1 Included with "Undistributed" to avoid disclosing individual company confidential data.
2 Included with "Michigan" to avoid disclosing individual company confidential data.
3 Data may not add to totals shown because of independent rounding.
4 Included with furnace plants to avoid disclosing individual company confidential data.
5 Revised to reflect inventory adjustments.

Table 42.—Coke-oven crude light oil produced in the United States and derived products produced and sold in 1975, by State
(Thousand gallons)

State	Active plants[1]	Crude light oil				Derived products		
		Produced	Gallons per ton of coal	Refined on premises[2]	Stocks, Dec. 31	Produced	Sold[3] Quantity	Sold[3] Value (thousands)
Alabama	7	12,410	1.84	110	1,421	486	509	$139
California, Colorado, Utah	3	15,503	3.23	8,383	430	6,797	6,566	4,580
Illinois	4	7,008	2.27	12	225	--	--	--
Indiana and West Virginia	7	39,693	2.69	524	594	503	517	221
Kentucky, Michigan, Missouri, Tennessee, Texas	5	10,610	1.80	1,167	321	1,087	1,074	622
Maryland and New York	4	21,545	2.87	10,322	1,113	9,099	8,941	6,856
Ohio	11	28,135	2.32	9,250	691	7,611	7,653	5,358
Pennsylvania	10	59,910	2.80	65,409	2,779	56,725	56,625	39,644
Total 1975[4]	51	194,814	2.55	95,178	7,574	82,308	81,885	57,419
At merchant plants	6	7,238	1.78	([5])	788	([5])	([5])	([5])
At furnace plants	45	187,576	2.60	95,178	6,786	82,308	81,885	57,419
Total 1974	51	217,416	2.64	121,363	[6] 6,947	105,443	104,552	73,654

[1] Number of plants that recovered crude light oil.
[2] Includes small quantity of material also reported in sales of crude light oil in table 33.
[3] Excludes 99,005,000 gallons of crude light oil valued at $44,234,000 sold as such.
[4] Data may not add to totals shown because of independent rounding.
[5] Included with furnace plants to avoid disclosing individual company confidential data.
[6] Revised to reflect inventory adjustments.

Table 43.—Yield of light oil derivatives from refining crude light oil at oven-coke plants in the United States
(Percent)

Year	Benzene (all grades)	Toluene (all grades)	Xylene (all grades)	Solvent naphtha (crude and refined)	Other light oil products
1971	65.6	12.4	2.8	3.2	5.0
1972	59.3	12.8	3.1	3.0	4.7
1973	61.2	11.3	2.8	2.7	5.5
1974	60.2	11.5	2.7	2.9	4.7
1975	61.0	11.7	2.1	2.5	5.5

Table 44.—Benzene and toluene produced at oven-coke plants in the United States, by grade
(Thousand gallons)

Year	Benzene		Toluene (all grades)
	Specification grades (1°, 2°, 90%)	Other industrial grades	
1971	68,756	3,391	13,345
1972	76,317	3,532	14,571
1973	84,876	3,299	14,496
1974	82,149	([1])	13,567
1975	65,050	([1])	9,841

[1] Included with "Specification grades" to avoid disclosing individual company confidential data.

Table 45.—Light oil derivatives produced at oven-coke plants in the United States and sold in 1975, by State

(Thousand gallons and thousand dollars)

State	Benzene (all grades)				Toluene (all grades)			
	Produced	Yield from crude light oil refined (percent)	Sold		Produced	Yield from crude light oil refined (percent)	Sold	
			Quantity	Value			Quantity	Value
Alabama	15,090	76.2	15,014	11,347	--	--	--	--
Colorado and Utah	(1)	(1)	(1)	(1)	(2)	(2)	(2)	(2)
Maryland, Michigan, Texas	(1)	(1)	(1)	(1)	1,238	11.6	993	453
Ohio	6,127	61.1	6,134	4,566	1,111	12.6	1,168	624
Pennsylvania	43,834	57.0	45,136	33,812	7,492	11.6	8,294	4,462
Total 1975[3,4]	65,050	61.0	66,283	49,724	9,841	11.7	10,455	5,539
Total 1974	82,149	60.2	83,114	63,442	13,567	11.5	13,105	6,981

State	Xylene (all grades)				Solvent naphtha (crude and refined)			
	Produced	Yield from crude light oil refined (percent)	Sold		Produced	Yield from crude light oil refined (percent)	Sold	
			Quantity	Value			Quantity	Value
Alabama	--	--	--	--	--	--	--	--
Colorado and Utah	(2)	(2)	(2)	(2)	(5)	(5)	(5)	(5)
Maryland, Michigan, Texas	253	1.6	294	176	(5)	(5)	(5)	(5)
Ohio	245	3.7	216	122	127	(5)	(5)	(5)
Pennsylvania	1,386	2.1	1,448	785	1,918	2.5	1,947	652
Total 1975[3,4]	1,884	2.1	1,958	1,083	2,045	2.5	1,947	652
Total 1974	3,135	2.7	3,050	1,677	2,736	2.9	2,643	700

[1] Included with Alabama to avoid disclosing individual company confidential data.
[2] Included with Maryland and Texas to avoid disclosing individual company confidential data.
[3] Data may not add to totals shown because of independent rounding.
[4] Data not broken down into merchant and furnace plants to avoid disclosing individual company confidential data.
[5] Included with Ohio to avoid disclosing individual company confidential data.

Columbium and Tantalum

By Henry E. Stipp [1]

Consumption of columbium in the form of ferrocolumbium, ferrotantalum-columbium, and other columbium and tantalum materials decreased 28% in 1975 to 3.3 million pounds of contained columbium and tantalum, compared with consumption of about 4.6 million pounds in 1974. Consumer stocks of ferrocolumbium, ferrotantalum-columbium, and other columbium and tantalum materials, which were built-up to new high quantities in 1974, were reduced 35% to 1.1 million pounds (contained Cb and Ta), compared with 1.7 million pounds in 1974. The decreased consumption of columbium in steels and superalloys was the result of a downturn in the economy which affected automobile manufacture, building construction, and transportation. Oil and gas pipelines and offshore drilling platform construction was affected less than other sectors of the economy and accounted for a large part of the consumption of columbium in specialty steels.

Columbium consumption in raw materials decreased 34% in 1975 to about 2.1 million pounds (Cb content), compared with 3.2 million pounds in 1974.

Consumption of tantalum in raw materials decreased 56% in 1975 to about 1.1 million pounds (contained Ta), compared with 2.4 million pounds in 1974. Reduction of large inventories of tantalum by producers of electronic capacitors reportedly was mainly responsible for decreased sales of tantalum by domestic processors.

Imports of columbium mineral concentrates decreased 51% to 1.5 million pounds (gross weight), compared with 3.1 million pounds in 1974. Columbium concentrates came mainly from Brazil, 74%; Nigeria, 10%; and Malaysia, 9%. Ferrocolumbium imports from Brazil decreased 43% to about 1.9 million pounds (contained Cb), compared with 3.3 million pounds in 1974. Tantalum mineral concentrates imports were down 14% to about 1.6 million pounds (gross weight), compared with around 1.9 million pounds in 1974. Imports of tantalum concentrates came chiefly from Canada, 41%; Australia, 13%; and Brazil, 9%.

Legislation and Government Programs.—Sales of columbium and tantalum from U.S. Government stockpile excesses in 1975 amounted to 56,959 pounds (Cb content) of columbium concentrate and 64,653 pounds (Ta content) of tantalum concentrate. Shipments of columbium materials from U.S. Government stockpile excesses totaled 463,000 pounds (Cb content), and shipments of tantalum materials totaled 87,000 pounds (Ta content) for the same period. At yearend the General Services Administration (GSA) had sold all of the columbium and tantalum from stockpile excesses authorized by Congress; no further sales were expected to take place in the immediate future.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient columbium statistics
(Thousand pounds)

	1971	1972	1973	1974	1975
United States:					
Mine production of columbite-tantalite concentrates	--	--	--	--	--
Releases from Government excesses (Cb content) [1]	36	799	2,344	r 2,739	463
Consumption of raw materials (Cb content)	2,346	2,489	2,806	3,250	2,137
Production of primary products:					
Columbium metal (Cb content)	W	W	W	W	W
Ferrocolumbium (Cb content)	1,020	1,474	1,496	r 1,917	e 985
Consumption of primary products:					
Columbium metal (Cb content)	459	218	254	221	130
Ferrocolumbium, ferrotantalum-columbium and other columbium and tantalum materials (Cb and Ta content)	2,880	3,676	4,056	4,626	3,348
Exports: Columbium metal, compounds, and alloys (gross weight)	21	29	96	33	53
Imports for consumption:					
Mineral concentrate (Cb content)	1,289	1,558	1,314	r 1,550	820
Columbium metal and columbium-bearing alloys (Cb content)	1	1	4	1	3
Ferrocolumbium (Cb content) e	710	1,530	2,120	3,276	1,872
Tin slags (Cb content) [2]	526	547	603	460	144
World: Production of columbium-tantalum concentrates (Cb content) e	8,252	13,121	r 32,452	r 29,230	28,125

e Estimate. r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes columbium content in raw materials from which columbium is not recovered and material released as payment-in-kind for upgrading.
[2] Receipts reported by consumers.

Table 2.—Salient tantalum statistics
(Thousand pounds)

	1971	1972	1973	1974	1975
United States:					
Mine production of columbium-tantalum concentrates	--	--	--	r --	--
Releases from Government excesses (Ta content) [1]	6	87	266	r 884	87
Consumption of raw materials (Ta content)	1,116	1,280	2,221	2,425	1,077
Production of primary metal (Ta content)	892	1,352	1,619	r 1,849	844
Consumption of primary products:					
Tantalum metal (Ta content)	649	922	1,096	1,159	450
Ferrocolumbium and ferrotantalum-columbium and other columbium and tantalum materials (Cb and Ta content)	2,880	3,676	4,056	4,626	3,348
Exports:					
Tantalum ore and concentrate (gross weight)	48	19	16	201	60
Tantalum metal, compounds, and alloys (gross weight)	194	146	344	503	471
Tantalum and tantalum alloy powder (Ta content)	85	171	202	233	161
Imports for consumption:					
Mineral concentrate (Ta content)	502	458	428	r 744	594
Tantalum metal and tantalum-bearing alloys (Ta content)	40	74	101	184	66
Tin slags (Ta content) [2]	481	625	719	760	247
World: Production of columbium-tantalum concentrates (Ta content) e	1,093	818	r 847	909	900

e Estimate. r Revised.
[1] Includes material released as payment-in-kind for upgrading.
[2] Receipts reported by consumers.

Table 3.—Columbium and tantalum materials in Government inventories as of Dec. 31, 1975
(Thousand pounds, columbium and tantalum content)

Material	Objective	National (strategic) stockpile	Defense Production Act (DPA) Inventory	Supplemental stockpile	Total
Columbium:					
Concentrates	--	1,806	73	3	1,882
Carbide powder: Stockpile grade	16	21	--	--	21
Ferrocolumbium:					
Stockpile grade	748	1748 [1]	--	--	1748 [1]
Nonstockpile grade	--	183	--	--	183
Metal: Stockpile grade	36	45	--	--	45
Tantalum:					
Tantalum minerals: Stockpile grade	312	2,552	36	--	2,588
Carbide powder: Stockpile grade	3	29	--	--	29
Metal: Stockpile grade	45	201	--	--	201

[1] Includes 149,590 pounds of nonstockpile-grade material.

DOMESTIC PRODUCTION

There was no domestic mine production of columbium and tantalum reported in 1975.

Data on production of columbium metal powder and ingot are withheld to avoid disclosing proprietary company information. Generation of columbium metal scrap was 50,646 pounds, Cb content, compared with 126,240 pounds in 1974. Tantalum metal powder production (including capacitor-grade powder) decreased 54% to 844,389 pounds (contained Ta), compared with 1,849,177 pounds in 1974. Tantalum metal ingot production was 367,394 pounds (Ta content), a decrease of 48% from the 712,121 pounds in 1974. Scrap tantalum metal generation totaled 259,120 pounds (Ta content), compared with 406,056 pounds in 1974. Ferrocolumbium was produced by four domestic firms in 1975. Output decreased 49% to 985,000 pounds (Cb content), compared with 1,917,000 pounds in 1974.

A major titanium ore deposit that contains significant quantities of columbium was discovered.[2] Located in southwestern Colorado, the deposit reportedly contained 419 million tons of mainly perovskite ore (a calcium titanium oxide that contains columbium) based on a cutoff grade of 9% titanium dioxide (TiO_2) content.

[2] American Metal Market. Buttes Says Studies Indicate Major Titanium Ore Deposit. V. 83, No. 38, Feb. 25, 1976, p. 8.

Table 4.—Major domestic columbium and tantalum processing and producing companies in 1975

Company	Location	Columbium	Tantalum	Tantalum carbide	Ferro-columbium
Fansteel Inc	Chicago, Ill	X	X	X	--
	Muskogee, Okla	--	--	--	--
General Electric Co	Warren, Mich	--	--	X	--
Kawecki Div., Kawecki Berylco Industries, Inc.	Boyertown, Pa	X	X	X	X
Kennametal, Inc	Latrobe, Pa	X	X	X	--
Mallinckrodt Inc	St. Louis, Mo	X	X	--	--
Metals Div., Norton Co	Newton, Mass	X	X	X	--
Newcomer Products, Inc	Latrobe, Pa	X	--	X	--
Reading Alloys Co., Inc	Robesonia, Pa	X	--	--	X
Shieldalloy Corp	Newfield, N.J	X	--	--	X
Wah Chang Albany (A Teledyne Company).	Albany, Oreg	X	X	X	X

CONSUMPTION AND USES

High-purity columbium metal consumption totaled 130,130 pounds, a decrease of 41% from the 220,696 pounds consumed in 1974. The principal end use for high-purity columbium metal, in powder and ingot form, was in high-temperature superalloys required mainly by the aerospace industry.

Tantalum metal consumption, decreased 61% to 450,250 pounds, compared with 1,159,201 pounds in 1974. The principal end uses for tantalum metal was in capacitors and other electronic equipment, and in corrosion-resistant chemical equipment. Consumption of capacitor-grade powder decreased 99% from that of 1974; consumption of tantalum in the manufacture of chemical equipment decreased about 54% from that of 1974. Tantalum carbide consumption in cutting tool applications decreased 22% from that of 1974.

Columbium and tantalum in the form of ferroalloys were added to steels to control the formation of carbon and nitrogen compounds, to improve yield strength and weldability, and to increase low-temperature strength and toughness. Consumption of ferrocolumbium, ferrotantalum-columbium, and other columbium and tantalum materials in steelmaking decreased 19% to 2,744,299 pounds of contained columbium and tantalum, compared with 3,388,601 pounds in 1974. Columbium and tantalum, consumed in the form of ferroalloys in 1975, by major end use categories, was as follows: High-strength, low-alloy steel, 31%; carbon steel, 24%; stainless and heat-resisting steel, 14%; superalloys, 13%; full alloy steel, 12%; and alloys (excluding alloy steels and superalloys), 2%. Ferrotantalum-columbium consumption was negligible accounting for 1% of total columbium and tantalum ferroalloys consumption. The major end use for ferrotantalum-columbium was in stainless and heat-resisting steel.

The use of columbium in high-strength, low-alloy steel was 16% less than in 1974; however, consumption in this category was expected to increase because of greater use in automobiles, oil and gas pipelines, offshore-drilling platforms, ship plate steel, and heavy machinery steel. Applications for high-strength, low-alloy steel in automobiles included bumpers and bumper reinforcements, engine mounts, bumper energy absorbers, wheel spiders, door intrusion beams, and tie rod sleeves. Research and development on a number of columbium metal alloys as superconductors of electricity at cryogenic temperatures was reported.

Table 5.—Reported shipments of columbium and tantalum materials
(Pounds of metal content)

Material	1974	1975	Change (percent)
Columbium products:			
Compounds, including alloys	1,520,500	930,800	−39
Metal, including worked products	133,400	112,700	−16
All other	34,000	21,200	−38
Total columbium	1,687,900	1,064,700	−37
Tantalum products:			
Oxides and salts	226,100	127,400	−44
Alloy additive	24,800	8,500	−66
Carbide	163,400	106,500	−35
Powder and anodes	929,400	436,600	−53
Ingot (unworked consolidated metal)	1,700	1,000	−41
Mill products	288,800	172,000	−40
Scrap	45,600	13,000	−71
Other	1,300	--	−100
Total tantalum	1,681,100	865,000	−49

Source: Tantalum Producers Association.

Table 6.—Consumption of ferrocolumbium, ferrotantalum-columbium, and other colombium and tantalum materials in the United States in 1975, by end use

(Pounds)

End use	Contained columbium and tantalum
Steel:	
Carbon	815,467
Stainless and heat-resisting	452,234
Full alloy	413,345
High-strength, low-alloy	1,050,581
Electric	W
Tool	12,672
Superalloys	446,181
Alloys (excluding alloy steels and superalloys)	81,868
Miscellaneous and unspecified	75,889
Total	3,348,237

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."

STOCKS

Processor and dealer inventories of columbium and tantalum materials at yearend were as follows, in pounds, contained columbium and tantalum:

Material	Dec. 31, 1974	Dec. 31, 1975
COLUMBIUM		
Primary metal	r 86,590	54,560
Ingot	36,548	33,344
Scrap	112,817	55,453
Oxide	536,538	949,333
Other compounds	r 12,741	16,226
TANTALUM		
Primary metal	213,855	232,003
Capacitor-grade powder	r 108,226	97,457
Ingot	82,620	84,527
Scrap	r 278,203	312,960
Oxide	69,580	74,962
Potassium tantalum fluoride	138,673	98,501
Other compounds	56,674	48,474

r Revised.

Columbium and tantalum stocks of raw materials, reported by processors and dealers at yearend 1975, in thousand pounds, contained Cb or Ta, (1974 figures in parentheses), were as follows: Columbite, Cb-552, Ta-69, (Cb-1,303, Ta-159); tantalite, Ta-976, Cb-545, (Ta-568, Cb-507); tin slag, Ta-2,667, Cb-2,092, (Ta-2,645, Cb-2,034); and pyrochlore, Cb-28, Ta—, (Cb-169, Ta—).

Stocks of ferrocolumbium, ferrotantalum-columbium, and other columbium and tantalum materials held by consumers as of December 31, 1975 were as follows (stocks on December 31, 1974 in parentheses): Ferrocolumbium, 1,091,372 (1,719,425) pounds of contained columbium; ferrotantalum-columbium, 10,500 (10,837) pounds of contained columbium and tantalum; and other columbium and tantalum materials, 30,744 (46,947) pounds of contained columbium and tantalum. Producer stocks of ferrocolumbium at yearend 1975 were 1,077,500 (1,145,100) pounds of contained columbium.

PRICES

Contract rates for Canadian pyrochlore, f.o.b. mine and mill, which decreased to $1.56 per pound of contained columbium oxide (Cb_2O_5) on September 9, 1974, remained at that level throughout 1975. Prices for Brazilian pyrochlore were quoted as nominal throughout 1975. For material having a Cb_2O_5 to Ta_2O_5 ratio of 10 to 1, spot columbite ore, c.i.f. U.S. ports was $1.60 to $1.70 per pound, at the beginning of the year, and advanced to $1.80 to $1.90 per pound of contained pentoxides on January 9, 1975. It remained at that price throughout 1975.

Spot prices for low-alloy grades (15:1 ratio) of ferrocolumbium per pound of contained columbium (Cb), ton lots, f.o.b. shipping point, were $4.00 to $4.12 per pound on January 9, 1975, increased to $4.30 per pound of contained columbium on October 27, 1975, and remained at that level for the balance of the year. Prices for high-purity grades, same basis, were $8.61 to $8.65 per pound of contained Cb throughout 1975.

U.S. reactor-grade columbium ingot was quoted at $18 to $25 per pound of columbium throughout 1975. U.S. reactor-grade columbium powder was quoted at $30 to $45 per pound throughout 1975.

Spot tantalite ore was quoted at $13.75 to $16 per pound of tantalum oxide (Ta_2O_5), 60% basis, c.i.f. U.S. ports, on December 13, 1974; decreased to $13.75 to $14.50 per pound of contained tantalum oxide on February 7, 1975, and on December 30, 1975 increased to $15.50 to $16.50 per pound of Ta_2O_5 content. Tantalum Mining Corporation of Canada Ltd. (TANCO) tantalite was quoted at $15 per pound of contained Ta_2O_5 throughout 1975.

U.S.-grade tantalum powder was quoted at $35.40 to $44.50 per pound of tantalum (Ta) throughout the year. U.S. rod was $45 to $54 per pound of tantalum, and advanced to $52 to $80 per pound of Ta on October 1, 1975. U.S. sheet tantalum was $50 to $57 per pound of Ta until October 1, 1975, when it advanced to $48 to $118 per pound of Ta and stayed at that level for the balance of 1975.

Thailand tin slag from the Thailand Smelting and Refining Co. Ltd. (Thaisarco) smelter, containing about 12% Ta_2O_5, was quoted at $5 per pound of contained Ta_2O_5 at the beginning of the year, and was quoted as nominal for the balance of the year.

Table 7.—Average grade of concentrate received by U.S. consumers and dealers in 1975, by country of origin
(Percent contained pentoxides)

Country	Columbite		Tantalite	
	Cb_2O_5	Ta_2O_5	Ta_2O_5	Cb_2O_5
Australia	--	--	40	14
Brazil, pyrochlore	58	--	--	--
Brazil, columbite and tantalite	53	17	36	27
Canada	--	--	53	4
Germany, West	--	--	35	31
Malaysia	51	19	23	45
Mozambique	--	--	54	19
Nigeria	63	8	--	--
Portugal	--	--	33	35
Rhodesia, Southern	--	--	34	16
Rwanda	43	27	28	41
South Africa, Republic of	42	32	26	41
Spain	39	30	32	34
Thailand	38	20	29	34
Uganda	--	--	27	35
Zaire	--	--	33	38

FOREIGN TRADE

Exports of columbium and columbium alloys, unwrought and waste and scrap, were shipped from the United States mainly to Mexico, 64%; the United Kingdom, 31%; and Japan, 5%. Wrought columbium and columbium alloys went chiefly to Canada, 31%; West Germany, 26%; and the United Kingdom, 24%.

Tantalum ores and concentrates were exported to Belgium, 63%; Japan, 19%; and West Germany, 18%. Wrought tantalum and tantalum alloys, shipped from the United States, went mainly to West Germany, 38%; the United Kingdom, 30%; and France, 10%. Crude tantalum metals and alloys, and scrap were exported chiefly to West Germany, 61%; the United Kingdom, 28%; and Italy, 7%. U.S. exports of tantalum and tantalum-alloy powder were shipped primarily to West Germany, 34%; Japan, 22%; France, 15%; and the United Kingdom, 13%.

Imports for consumption of columbium mineral concentrates decreased 51% in quantity (gross weight) and 37% in value compared with those of 1974. Columbium unwrought and waste and scrap, imported from the Netherlands, 60% and West Germany, 40%, totaled 844 pounds valued at $9,479. Unwrought columbium alloys, all from Canada, were 24 pounds valued at $422. Imports of wrought columbium metal, mainly from Japan, amounted to 2,195 pounds valued at $14,203.

Tantalum mineral concentrates, imported for consumption, decreased 14% in quantity (gross weight), but remained at about the same value as in 1974. Unwrought tantalum and tantalum waste and scrap, imported mainly from West Germany, 36%; Mexico, 28%; and the United Kingdom, 17%, totaled 128,041 pounds valued at $959,844. Unwrought tantalum alloys, chiefly from Canada, amounted to 190 pounds valued at $2,924. Imports of wrought tantalum metal, primarily from West Germany, 50%; the United Kingdom, 32%; and Belgium-Luxembourg, 11%, totaled 1,994 pounds valued at $35,313.

Tin slag imports, mainly from Thailand, 93%; and Brazil, 5%; decreased 71% in gross weight from that of 1974.

Table 8.—U.S. exports of columbium and tantalum, by class
(Thousand pounds, gross weight, and thousand dollars)

Class	1974		1975	
	Quantity	Value	Quantity	Value
Columbium and columbium alloys, unwrought and waste and scrap	12	113	17	61
Columbium and columbium alloys, wrought	21	450	36	726
Tantalum ores and concentrates	201	467	60	165
Tantalum and tantalum alloys, wrought	54	3,038	34	1,928
Tantalum metals and alloys, in crude form and scrap	449	3,308	437	3,452
Tantalum and tantalum alloy powder	233	7,008	161	5,974

Table 9.—Receipts of tin slags reported by consumers
(Thousand pounds)

Year	Gross weight	Cb_2O_5 content	Ta_2O_5 content
1971	9,064	753	596
1972	r 9,709	r 780	r 741
1973	8,607	863	878
1974	r 8,207	r 657	r 910
1975	2,283	205	288

r Revised.

Table 10.—U.S. imports for consumption of columbium-mineral concentrates, by country
(Thousand pounds and thousand dollars)

	1974				1975			
	Gross weight	Cb e content	Ta e content	Value	Gross weight	Cb e content	Ta e content	Value
Belgium-Luxembourg [1]	18	4	5	40	--	--	--	--
Brazil	2,349	952	--	1,958	1,135	460	--	1,215
Canada	9	3	--	8	21	7	--	22
China, People's Republic of	--	--	--	--	9	2	2	10
Germany, West	100	23	29	282	--	--	--	--
Malaysia	204	70	25	401	138	49	21	313
Nigeria	328	140	21	301	151	66	10	166
Portugal	20	5	6	50	16	4	5	54
Rwanda	23	7	6	59	--	--	--	--
South Africa, Republic of	--	--	--	--	2	(2)	(2)	10
Spain	--	--	--	--	11	3	2	55
Thailand	55	10	15	51	44	12	7	122
Zaire	23	6	6	57	15	3	--	45
Total	3,129	1,220	113	3,207	1,542	606	47	2,012

e Estimated by Bureau of Mines.
[1] Presumably country of transshipment rather than original source.
[2] Less than ½ unit.

Table 11.—U.S. imports for consumption of tantalum-mineral concentrates, by country
(Thousand pounds and thousand dollars)

	1974				1975			
	Gross weight	Cb [e] content	Ta [e] content	Value	Gross weight	Cb [e] content	Ta [e] content	Value
Australia	90	17	34	394	203	20	66	1,156
Belgium-Luxembourg [1]	14	3	4	96	7	--	--	36
Brazil	159	37	59	563	151	29	44	526
Canada	789	72	310	3,571	664	19	279	3,471
Congo	11	3	3	33	--	--	--	--
Germany, West	113	26	32	173	33	7	10	36
Japan	98	24	28	426	--	--	--	--
Kenya	--	--	--	--	7	1	2	31
Malaysia	135	29	29	293	86	27	16	146
Mozambique	35	11	10	207	66	9	29	452
Netherlands	30	(2)	12	297	7	(2)	2	54
Portugal	11	3	3	30	15	3	4	60
Rhodesia	2	(2)	(2)	4	12	1	3	58
Rwanda	70	21	17	187	87	25	20	202
South Africa, Republic of	3	(2)	(2)	9	--	--	--	--
Spain	100	27	26	302	45	10	11	166
Tanzania	17	4	7	57	--	--	--	--
Thailand	115	22	31	273	81	20	19	190
Uganda	12	4	3	30	11	3	2	28
Zaire	93	27	23	224	149	40	40	537
Total	1,897	330	631	7,169	1,624	214	547	7,149

[e] Estimated by Bureau of Mines.
[1] Presumably country of transshipment rather than original source.
[2] Less than ½ unit.

WORLD REVIEW

Australia.—A description of the Greenbushes Mineral Field was published.[3] Located on the Southwest Highway 158 miles (254 kilometers) south of Perth, the mineral area covers approximately 35.9 square miles (93 square kilometers). Greenbushes Tin N.L., the largest producer in the area, mines tin and tantalite ore from a pegmatite dike that outcrops for 1.5 miles (2.4 kilometers) parallel to the Southwest Highway. The company treats about 598,000 cubic yards of ore per year, producing a rough concentrate containing around 30% cassiterite and tantalite. This is refined at a dry concentrating plant to a final product containing about 47% Ta_2O_5, 30% Cb_2O_5, 2% TiO_2, and 1.7% Sn. Production in 1975 was 83,333 pounds of tantalum oxide (Ta_2O_5), and it has averaged 113,128 pounds per year from 1971 through 1975. Reserves of cassiterite and tantalite ores were reported at 2.9 million cubic yards.

Brazil.—Companhia Brasileira de Metalurgia e Mineração reportedly exported 10,469 tons (estimated to contain 15 million pounds Cb) of ferrocolumbium to world markets in 1975.

Canada.—St. Lawrence Columbium & Metals Corp. reportedly produced 4.2 million pounds of columbium oxide in concentrate in 1974.[4] Expansion of capacity could increase output in 1975 to about 5.5 million pounds and to about 8 million pounds in 1977.[5] St. Lawrence planned to reactivate its ferroalloy plant in 1976 to produce ferrocolumbium and eventually ferrovanadium and ferrotungsten. Shipments of columbium concentrate by St. Lawrence in 1975 were valued at $6.48 million, compared with shipments valued at $6.68 million in 1974.

Niobec Inc. planned to produce 5.5 million pounds of columbium concentrate grading 60% Cb_2O_5 starting in April 1976.[6] The mine and mill located at St. Honore, Quebec, near Chicoutimi has a capacity of 1,500 tons per day of ore, and is designed so that capacity can be increased 25% to 30% easily. Ore reserves capable of mining by open pit were estimated at 600 million pounds of columbium oxide (Cb_2O_5). Reportedly Niobec Inc. has 5-

[3] Tantalum Producers International Study Center (TIC). Greenbushes Mineral Field Australia. Quarterly Bulletin, Third Quarter, September 1975, p. 2.
[4] Metal Bulletin. Cb's Modest Future. No. 5969, Feb. 25, 1975, p. 26.
[5] Boucher, M. Additive, Refractory and Reactive Metals. Can. Min. Surv. Energy, Mines and Res., Canada, 1975, pp. 57–58.
[6] American Metal Market. Niobec Set to Join Select Columbium Producers Group. V. 83, No. 30, Feb. 12, 1976, pp. 1, 9.

year contracts for the sale of 60% of planned production to the United States, European, and Japanese consumers.

A report was published describing the Bernic Lake tantalum deposit of Tantalum Mining Corp. of Canada Ltd.[7] The most abundant tantalum minerals in the deposit were said to be wodginite, tantalite, and microlite. Reserves of tantalum ore, calculated from diamond drill cores after applying a factor for percent of Ta_2O_5 present were reported on January 1, 1976 as 936,613 tons of ore grading 0.150% tantalum oxide (Ta_2O_5). Two economic tantalum bearing zones in the pegmatite are known as the shaft ore body and the west ore body. A 700-foot-long section between the two ore bodies contains lepidolite, minor microline, and aplitic albite, and could contain minable quantities of tantalum in some sections; however, this area has not been included in reserves. The area east of the shaft ore body has potential tantalum ore, but has not been measured. A second pegmatite sill 100 feet below the main pegmatite ore body has yielded tantalum-bearing drill intersections, but it has not been adequately measured and it is not included in reserves.

Malaysia.—The smelting of tin concentrates at Penang, Malaysia and the resulting production of tantalum bearing tin slag was described.[8] From 1930 to around 1950, Malaysia and Thailand tin concentrates were smelted at Penang and the slag used mainly for earthfill. After 1950 Union Carbide Corp. purchased large quantities of tin slags and the earthfill dumps were redug, the slag cleaned and shipped to the United States. In 1967, the Thaisarco smelter at Phuket, Thailand began smelting tin concentrates produced in Thailand. Tin concentrates going to the Malaysian smelters since 1967 are lower in contained tantalum, ranging from 0.05% to 0.50% tantalum content. The tantalum to columbium ratio is about 1 to 1.2. At the present time, two smelters are operating at Penang; Datuk Keramat Smelting, Bhd. and Straits Trading Co. Ltd. Primary slags produced are analyzed and graded by tantalum content into high, medium, and low groups, which are stocked. Resmelted or secondary slag is produced in three grades averaging 3.5% Ta_2O_5, 2.75% Ta_2O_5, and under 2% Ta_2O_5. In 1974, Malaysia produced 2,276 tons of slag averaging 2.80% Ta_2O_5 or 140,500 pounds Ta_2O_5 content. From 1965 through 1974, slag production averaged 3,513 tons containing an average 2.68% Ta_2O_5 content.

Thailand.—The Thai Government completed its takeover of the offshore tin mining concessions of Thai Exploration and Mining Co. (TEMCO).[9] TEMCO was owned by Union Carbide Corp., 46%; Billiton N.V., a Netherlands based firm, 46%; and the Thai Government, 8%. In December Union Carbide Corp. sold its holdings in TEMCO, Thaisarco, and several other firms outside Thailand to Billiton N.V.[10] Thaisarco produces for sale tin slags that contain up to 12% tantalum oxide (Ta_2O_5).

[7] Tantalum Producers International Study Center (TIC). Tantalum Mining Corporation of Canada Limited (Bernic Lake). Quarterly Bulletin, First Quarter, February 1976, p. 2.

[8] Tantalum Producers International Study Center (TIC). Tin Slag Production at Datuk Keramat Smelting in Penang. Quarterly Bulletin, Fourth Quarter, December 1975, p. 2.

[9] American Metal Market. Thailand Completes Its Takeover of Temco Tin Mining Concessions. V. 82, No. 86, May 2, 1975, p. 5.

[10] Tantalum Producers International Study Center (TIC). Thailand Smelting and Refining Co. Ltd. Quarterly Bulletin, First Quarter, February 1976, p. 1.

Table 12.—Columbium and Tantalum: World production of mineral concentrates, by country [1]

(Thousand pounds)

Country [2]	Gross weight [3]			Columbium content [4]			Tantalum content [4]		
	1973	1974	1975 p	1973	1974	1975 p	1973	1974	1975 p
Argentina:									
Columbite	3	1	e 1	5 e 1	5 e 1	5 e 1	1	(6)	(6)
Tantalite	2	1	e 1	(6)	(6)	(6)	1	(6)	(6)
Australia:									
Columbite-tantalite	r 439	282	e 265	r 95	53	e 26	r 162	106	e 87
Brazil:									
Columbite-tantalite	373	203	e 198	73	47	e 37	113	75	e 58
Pyrochlore	42,827	39,414	e 39,683	28,663	24,795	24,251	--	--	--
Canada:									
Pyrochlore	e 6,360	r e 8,483	e 7,434	7 2,221	7 2,959	7 2,596	--	--	--
Tantalite	e 318	r e 818	737	13	32	30	140	352	324
Malaysia:									
Columbite-tantalite	203	183	e 165	74	63	e 59	18	19	e 26
Mozambique:									
Tantalite	64	88	e 106	13	27	14	21	25	47
Microlite	123	117	110	5	5	4	68	64	61
Nigeria:									
Columbite	r 2,751	2,631	2,183	r 1,211	1,121	960	r 226	147	144
Tantalite	2	1	3	(6)	(6)	1	1	(6)	1
Portugal:									
Tantalite	26	20	18	7	5	4	r 7	5	4
Rhodesia:									
Columbite-tantalite e	90	90	90	11	17	10	34	27	25
Rwanda:									
Columbite	72	82	100	22	25	30	17	20	22
South Africa, Republic of:									
Tantalite	--	1	--	--	(6)	--	--	(6)	--
Thailand:									
Columbite	18	68	15	6	23	4	2	7	3
Tantalite	35	134	227	7	25	54	9	36	54
Uganda: Columbite-tantalite e	6	8	5	2	3	1	1	1	1
Zaire: Columbite-tantalite e	102	102	161	28	29	43	26	25	43
Total	53,814	52,727	51,502	32,452	29,230	28,125	847	909	900

e Estimate. p Preliminary. r Revised.

[1] Excludes columbium and tantalum-bearing tin concentrates and slag.

[2] In addition to the countries listed, Burundi, Spain, South-West Africa, the U.S.S.R. and Zambia also produce or are believed to produce columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

[3] Data on gross weight generally has been presented as reported in sources, divided into concentrates of columbite, tantalite, pyrochlore and microlite where information is available to do so, and reported in groups such as columbite-tantalite where it is not.

[4] Unless otherwise specified, content is estimated on the basis of the content reported for the United States imports from the country in question. Estimates specifically marked as estimates are based on estimated gross weights.

[5] Content calculated on the basis of data in source publication recording gross weight.

[6] Less than ½ unit.

[7] Content calculated in terms of metal from data reported in source publication in terms of contained pentoxide.

TECHNOLOGY

The Federal Bureau of Mines released results of research conducted on preparing nitride compounds of columbium, vanadium, and tantalum and on methods of decomposing these compounds to obtain pure metals.[11] Oxides of the metals studied were reacted with ammonia in vertical, gas-solids reactors at 300° C to 1,300° C to produce metal nitrides. Improved results were obtained by using a rotary kiln. Products with less than 1% oxygen were obtained in about 6 hours under optimized conditions. Solid-state purification and arc and electron-beam melting were used to decompose the metal nitrides. Columbium and tantalum of 99.9% purity was prepared by electron-beam melting of the respective metal nitride.

Trace impurities in high-purity columbium were determined by irradiation of a sample with protons and detection of the gamma and X-rays given off with a gallium-lithium and germanium detector.[12] Impurities determined were titanium, vanadium, chromium, iron, zirconium, molybdenum, hafnium, tantalum, and tungsten. Lead, tin, and antimony were not present; however, they could have been determined, if present.

A technical-grade columbium oxide containing 95% Cb_2O_5 was obtained by chlorination of pyrochlore concentrate at 700° C in the presence of carbon, and by absorbing the volatilized columbium oxychloride ($CbOCl_2$) in water.[13] The product was filtered, dried, and calcined. Rare earths and thorium were recovered by leaching the residue with water. A mixture of chlorine and sulfur dioxide reacted with pyrochlore concentrate at 300° C to 700° C also was studied. Results indicated that columbium oxychloride and calcium sulfate were formed.

The hardness of columbium alloyed with zirconium, hafnium, molybdenum, tungsten, rhenium, ruthenium, osmium, rhodium, or iridium was tested.[14] Results suggest that an extrinsic mechanism, such as solute-interstitial interaction was responsible for the softening in tantalum and columbium alloys.

Alloys of columbium with gallium were studied for their crystal structure.[15] Arc-melted, annealed, and powdered specimens containing from 28 to 45 atomic percent gallium were analyzed by metallographic and X-ray diffraction analyses. Three intermediate phases, Cb_3Ga, Cb_5Ga_3, Cb_5Ga_4, and also $Cb_5Ga_3O_x$ were detected.

The corrosion of columbium, tantalum, and vanadium metal in flowing, liquid sodium was studied.[16] It was concluded that group 5A metals formed ternary oxide corrosion products when exposed to liquid sodium containing more than 5 parts per million of oxygen. These metals and possibly their alloys, used as structural materials in high-temperature regions of liquid-metal cooled, fast-breeder reactors, would be subject to rapid corrosion at normal reactor oxygen levels, and spalling and transport to other regions of the system by the flowing liquid sodium.

A method of producing a spiral band of columbium-tin superconducting alloy around a thin columbium ribbon was reported.[17] The columbium-tin superconductor was fabricated from 0.001-inch and 0.5-inch-wide columbium ribbon. The columbium-tin material was superconductive to higher magnetic field strength, temperature, and current than most other superconductors.

Introduction of hydrogen into columbium - palladium, columbium - palladium - molybdenum, and columbium-palladium-tungsten alloys was studied for its influence on the superconducting transition temperature.[18] Most alloys tested showed

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[11] Guidotti, R. A., G. B. Atkinson, and D. G. Kesterke. Nitride Intermediates in the Preparation of Columbium, Vanadium, and Tantalum Metals. (In Two Parts). 1. Nitride, Preparation. BuMines RI 8079, 1975, 25 pp.
———. Nitride Intermediates in the Preparation of Columbium, Vanadium, and Tantalum Metals. (In Two Parts). 2. Thermal Decomposition of the Nitrides. BuMines RI 8103, 1976, 15 pp.

[12] Krivan, V. Instrumental Multielement Proton Activation Analysis of High-Purity Niobium Using Both Gamma Ray and X-Ray Spectrometry. Anal. Chem., v. 17, No. 3, March 1975, pp. 469–478.

[13] Habashi, F., and I. Malinsky. Technical Niobium Oxide From Pyrochlore. Can. Min. and Met. Bull., v. 68, No. 761, September 1975, pp. 85–90.

[14] Stephens, J. R., and W. R. Witzike. Hardness Behavior of Binary and Ternary Niobium Alloys at 77 and 300 K. J. Less-Common Metals, v. 40, No. 2, April 1975, pp. 195–205.

[15] Brown, P. W., and F. J. Worzala. The Structure of Nb_5Ga_3. J. Less-Common Metals, v. 41, No. 1, June 1975, pp. 77–85.

[16] Barker, M. G., and C. W. Morris. The Corrosion of Group 5A Metals in Flowing Sodium. J. Less-Common Metals, v. 42, No. 2, September 1975, pp. 229–239.

[17] Materials Engineering. Flexible Superconductor Uses Columbium-Tin. V. 80, No. 7, December 1974, p. 49.

[18] Robbins, C. G., and J. Muller. The Effect of Hydrogen on the Superconducting Transition Temperature of Some Body-Centered Cubic Niobium-Palladium, Niobium-Pal'adium-Molybdenum and Niobium-Palladium-Tungsten Alloys. J. Less-Common Metals, v. 42, No. 1, August 1975, pp. 19–27.

at least one concentration of hydrogen that gave a higher superconducting transition temperature than that of the unhydrogenated material. The highest transition temperature discovered was 5.46 Kelvin for $(Cb_{85}Pd_{15})_9MO$ with hydrogen-metal (H/M)=0.51. It was concluded that the effect of hydrogen on the transition temperature of these alloys increased as the molybdenum content increased and, therefore, the superconducting properties of molybdenum hydrides should be studied.

A flexible superconducting cable was fabricated from columbium-tin.[19] Applications for columbium-tin superconductors have been slow to develop because of brittleness and bend resistance. Fabrication of the cable involved loading pure columbium rods jacketed with tin into a copper billet. The billet was then extruded and drawn into wire. Any desired diameter cable can be produced.

Rectangular cable was produced by twisting strands of a composite copper and columbium-titanium wire around a core of soft solder and pulling the bundle through a rectangular die.[20] Superconducting magnets in particle accelerators developed greater strength and higher efficiency with the rectangular copper and columbium-titanium wire.

The preparation of tantalum metal by the open-aluminothermic reduction of tantalum pentoxide (Ta_2O_5) and purification of the tantalum by melting in an electron-bombardment furnace or by a molten-salt electrorefining process was described.[21] Tantalum metal in a consolidated form, in good yield was obtained by reduction of tantalum pentoxide with aluminum in the presence of lime, as a slag fluidizer, and potassium chlorate as a heat booster.

A process for removing lead from pyrochlore before smelting was patented.[22] Pyrochlore concentrate was mixed with calcium chloride or other applicable chlorides and heated for 30 to 120 minutes at 700° C to 1,000° C, to volatilize lead chloride, and washed with water or dilute hydrochloric acid to remove the metal chloride.

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[19] Metal Progress. Specialty Metals. V. 108, No. 4, September 1975, p. 7.

[20] Chemical & Engineering News. Technology. V. 53, No. 30, July 28, 1975, p. 14.

[21] Nair, K. U., T. K. Mukherjee, and C. K. Gupta. Production of Tantalum Metal by the Aluminothermic Reduction of Tantalum Pentoxide. J. Less-Common Metals, v. 41, No. 1, June 1975, pp. 87–95.

[22] Kentro, D. M., and J. W. Cole (assigned to Molycorp Inc.). Method of Removing Lead Impurity From Pyrochlore Prior to Smelting. U.S. Pat. 3,862,836, Jan. 28, 1975, 4 pp.

Copper

By Harold J. Schroeder [1] and George J. Coakley [1]

World mine production of copper was 7.68 million tons, a decrease of 5% and a reversal from the preceding seven consecutive annual increases. The United States continued to lead the world in mine production, followed by Chile, the U.S.S.R., Canada, Zambia, Zaire, and Poland. Among these major producers, only Poland recorded a substantial increase, where an advance of 36% moved the country from a position of 10th to 7th largest. The lower world output was a reflection of the worldwide recession that severely reduced demand. Despite the curtailed production, stocks of refined copper were built-up to record high levels and prices were consequently depressed.

In the United States, consumption of refined copper and mine, smelter, and refinery outputs were all substantially smaller for the second consecutive year. Despite the curtailed output, the components of new supply exceeded consumption with a resultant buildup of industrial refined copper stocks and price cuts totaling 9 cents for a yearend quotation of 63 cents per pound for cathode copper. Foreign trade in unmanufactured copper was at a greatly reduced level in 1974, and net imports were a relatively small supply component. For refined copper, the largest trade category, exports exceeded imports.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient copper statistics

	1971	1972	1973	1974	1975
United States:					
Ore produced thousand short tons	242,656	266,831	289,998	293,443	263,003
Average yield of copper percent	0.55	0.55	0.53	0.49	0.47
Primary (new) copper produced—					
From domestic ores, as reported by—					
Mines short tons	1,522,183	1,664,840	1,717,940	1,597,002	1,413,366
Value thousands	$1,583,071	$1,704,796	$2,044,349	$2,468,964	$1,814,763
Smelters short tons	1,470,815	1,649,130	1,705,065	1,532,066	1,374,324
Percent of world total	22	22	22	19	18
Refineries short tons	1,410,523	1,680,412	1,698,337	1,420,905	1,286,189
From foreign ores, matte, etc., as reported by refineries do	181,259	192,821	170,151	233,753	157,189
Total new refined, domestic and foreign do	1,591,782	1,873,233	1,868,488	1,654,658	1,443,378
Secondary copper recovered from old scrap only do	445,157	458,194	486,214	483,432	369,173
Exports:					
Metallic copper do	262,838	241,600	292,504	246,205	304,712
Refined do	187,654	182,743	189,396	126,526	172,426
Imports, general:					
Unmanufactured do	359,479	415,611	420,513	608,602	324,126
Refined do	163,988	192,379	202,955	313,569	146,805

See footnotes at end of table.

Table 1.—Salient copper statistics—Continued

	1971	1972	1973	1974	1975
Stocks, Dec. 31: Producers:					
Refined ---------- short tons --	75,000	57,000	37,000	101,000	207,000
Blister and materials in solution ------------ do ----	303,000	281,000	265,000	324,000	312,000
Total -------------- do ----	378,000	338,000	302,000	425,000	519,000
Consumption:					
Refined copper -------- do ----	2,019,507	2,238,867	2,437,048	2,194,168	1,534,508
Apparent consumption, primary copper ----- do ----	1,623,000	1,901,000	1,902,000	1,778,000	1,312,000
Apparent consumption, primary and old copper (old scrap only) ---- do ----	2,068,000	2,359,000	2,388,000	2,261,000	1,681,000
Price: Weighted average, cents per pound --------------------	52.0	51.2	59.5	77.3	64.2
World:					
Production:					
Mine ----------- short tons --	6,688,634	7,321,950	r 7,844,901	r 8,063,457	7,678,948
Smelter -------------- do ----	6,591,741	7,404,601	r 7,878,480	r 8,110,822	7,779,908
Price: London, average cents per pound --------------------	48.49	48.53	80.86	93.13	56.08

r Revised.

Legislation and Government Programs.—The 1974 disposal of nearly 252,000 tons of refined copper reduced the inventory of refined copper in the national stockpile to 489 tons. The 7,067 tons of copper contained in beryllium-copper master alloys remained in inventory as a stockpile item.

The Office of Minerals Exploration is authorized to grant loans for up to 50% of approved costs on exploration for copper deposits. However, no loans involving copper have been awarded since 1969.

In November 1974, the U.S. Department of Commerce placed all copper raw materials, except scrap, under the Defense Priorities System. Prior to that date, only refined copper made from ores mined in the United States was subject to defense ratings. In January 1975, the Commerce Department rescinded the 5% set-aside applicable to domestic refined copper. In September 1975, the Commerce Department excluded all copper raw materials except intermediate shapes from priority ratings, thus making copper exempt from rated orders in a manner similar to that in effect prior to 1974. Defense-rated shipments of mill and foundry products were approximately 50,000 tons (copper content) in 1975.

Public Law 93–497, temporarily suspending the 0.8 cent per pound import duty on copper ores, concentrates, blister, and refined copper, expired on June 30, 1975. With the exception of July 1972–June 1973, the duty had been suspended since January 1966. A suspension of the duty on copper and copper-base scrap, however, has been continued through June 1978.

DOMESTIC PRODUCTION

Mine Production.—Domestic mine production of recoverable copper was 1.41 million tons, a 12% decline from that of 1974 and the smallest quantity since strike-disrupted 1968. Principal copper-producing States were Arizona, with 58% of the total, Utah (13%), New Mexico (10%), Montana (6%), Nevada (6%), and Michigan (5%). These States accounted for 98% of total production. Weak demand for copper and increased costs of production led to the permanent closure of several marginal underground operations, cutbacks, and temporary closures at other operating properties, and a slowdown of several new developments.

Open pit mines accounted for 80% of mine output and underground mines for 20%. The production of copper from dump and in-place leaching, mainly recovered by precipitation with iron, was 144,294 tons, or 10% of mine output. Total copper recovered by leaching methods was 231,760 tons, of which 194,495 tons was precipitated with iron and 37,265 tons was electrowon.

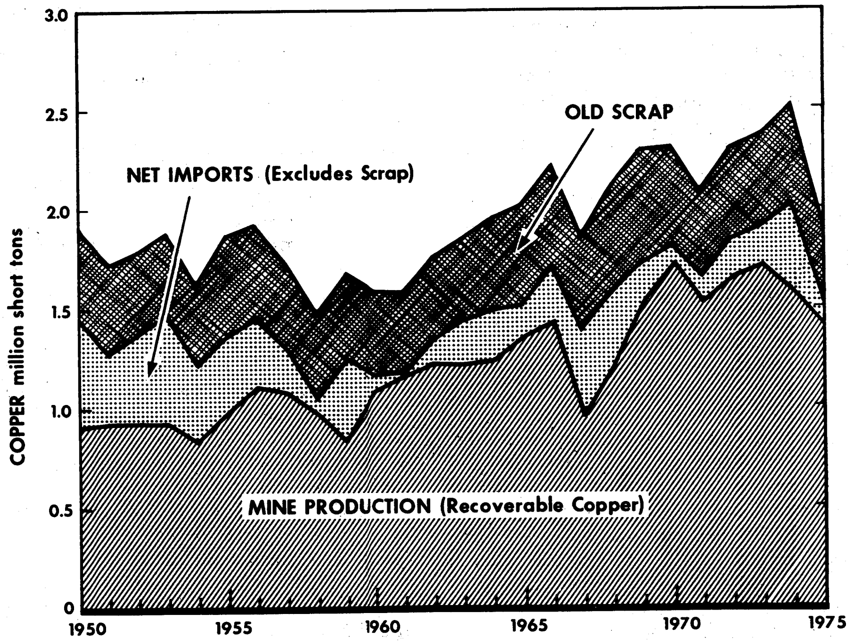

Figure 1.—Sources of copper supply for United States copper consumption.

Duval Corp., a subsidiary of Pennzoil Company, operated the Duval Sierrita open pit mine near Tucson, Ariz., milling a record 31.4 million tons of ore averaging 0.33% copper and 0.030% molybdenum. Reserves at yearend were estimated at 523 million tons grading 0.32% copper and 0.033% molybdenum. Duval also operated the Esperanza and Mineral Park copper-molybdenum open pit mines in Arizona and the Copper Canyon open pit copper mine in Nevada. These three operations milled 12.7 million tons of ore and also produced leach-precipitation copper from waste dumps. Total output from all operations was 127,721 tons of copper in concentrates and 11,170 tons of copper in precipitates.

The Anaconda Company produced 6,500 tons of copper from underground operations at Butte, Mont., compared with 17,450 tons in 1974, and reflected the phasing out of underground vein mining. Output at the Berkeley pit was 75,030 tons of copper compared with 98,890 tons in 1974. The Continental-East pit produced 12,680 tons of copper before closure in October due to depletion of ore reserves. Production of copper from the Yerington mine at Weed Heights, Nev., and the newly opened Victoria mine near Ely, Nev., totaled 41,190 tons compared with 37,970 tons in 1974. A major underground copper mine, the Carr Fork project in the Bingham District of Utah, was under development with completion scheduled for 1979. The initial rate of production was planned to be 48,000 tons per year with an increase to 56,000 tons 3 years later.

Anamax Mining Co., a joint venture of The Anaconda Company and AMAX Inc., operated the Twin Buttes, Ariz., open pit mine and produced 28,300 tons of copper compared with 40,140 tons in 1974. The 40,000-ton-per-day sulfide mill was shutdown in March to permit an intensified overburden-removal program. Startup of the 10,000-ton-per-day oxide ore leach-electrowinning plant began in August and approximately 6,700 tons of refined electrowon cathodes were produced.

Kennecott Copper Corp. operated mines in Arizona, Nevada, New Mexico, and Utah; these mines produced a combined total of 288,100 tons of copper, compared with 402,200 tons in 1974. The reduced output reflected shutdowns of from 2- to 12-week duration at the operating units because of the weak copper market. The Utah Copper Div. accounted for 171,500 tons of the total followed by Chino Mines Div. (New Mexico) with 53,200 tons, the Ray Mines Div. (Arizona) with 42,000 tons, and the Nevada Mines Div. with 21,400 tons. Development work on a potential copper deposit beneath the perimeter of the Utah Copper Division's Bingham Canyon open pit mine continued during 1975. Sinking a large shaft, underground core drilling, test mining to determine ground conditions, and metallurgical testing is scheduled for completion by 1981. Design engineering continued for development of a copper mine near Ladysmith, Wis. If undue delays are not encountered in obtaining mining and other permits, operation at an annual estimated production of 11,000 tons of copper in concentrates could be achieved by 1978.

ASARCO Incorporated operated three copper mines in the vicinity of Tucson, Ariz. The Mission and Silver Bell units operated on a reduced 5-day-per-week schedule through June, then following a 3-week vacation shutdown in July, operated on a 4-day-per-week schedule. Outputs at the two units were 26,900 tons and 18,300 tons of copper in concentrates and precipitates compared with 40,300 tons and 23,500 tons, respectively, in 1974. Production at the San Xavier mine and leach plant in the first full year of operation was 9,700 tons of copper in precipitates. The Sacaton mine and mill near Casa Grande, Ariz., also in its first full year of operation, produced 21,900 tons of copper in concentrates. Production was from an open pit but development work was underway for the mining of a deeper ore body by underground block-caving methods beginning in 1980.

Mines of the Phelps Dodge Corp. produced 249,686 tons of copper compared with 281,338 tons in 1974. The decrease reflected closure of the Lavender pit near Bisbee, Ariz., in December 1974, and the Bisbee underground mines on June 13, 1975, and reduced work schedules. These factors more than offset production from the Metcalf mine near Morenci, Ariz., which became operational in January and produced 29,195 tons of copper in concentrates, well below its 60,000-ton capacity. Output at Morenci, Ariz.; Ajo, Ariz.; and Tyron, N. Mex., was 100,775 tons, 33,025 tons, and 75,386 tons, respectively. The Bisbee operation contributed 5,600 tons and miscellaneous sources, mostly tailings retreatment, contributed 5,707 tons of copper. Underground development work continued at Safford, Ariz., toward eventual mining of a deep ore body containing an estimated 400 million tons of ore with an average grade of 0.72% copper. However, no decision was made on when to bring this property into production.

Cities Service Co., through its North American Chemicals and Metals Group, operated mines in Arizona and Tennessee that produced 46,900 tons of copper compared with 30,600 tons in 1974. The increased output reflected the first full year of operation of the Pinto Valley open pit mine and mill facilities near Miami, Ariz., at about 90% of design capacity of 40,000 tons of ore per day. Minable ore reserves of the Copper Cities and Diamond H mines near Miami were depleted but in situ leaching operations at declining rates were to continue for several years. A solvent extraction-electrowinning plant to replace the leach-precipitation plant was under construction with completion scheduled for mid-1976. Startup of the underground Miami-East mine, originally scheduled for 1976, was postponed because of escalated costs and adverse market conditions.

The White Pine, Mich., operations of White Pine Copper Co., milled a record high 9.0 million tons of copper ore averaging 1.01% copper with an 85.6% recovery of copper in concentrate. At yearend, extractable ore reserves to the present operating depth of 2,200 feet were estimated to be 94 million tons averaging 1.2% copper, assuming that 43% of the ore would be left in pillars and allowing a 9% grade dilution. Using similar assumptions, there is a probable extractable ore reserve of 128 million tons of ore averaging 1.06% copper at depths between 2,200 and 3,500 feet.

Magma Copper Co. operated two underground copper mines in Arizona with a combined output of 133,000 tons of copper in concentrate compared with 149,600 tons in 1974. Production at the San Manuel mine was reduced 23% as an adjustment to the weak copper market. At the smaller Superior mine, production was increased by 33% to achieve the best possible unit operating costs.

The Inspiration Consolidated Copper Co. operated the Thornton, Live Oak, Red

Hill, and Joe Bush open pit copper mines in the vicinity of Inspiration, Ariz.; 19.6 million tons of waste and 6.3 million tons of ore were mined for a combined 25.9 million tons of material handled. Approximately 5.4 million tons of the ore was treated in the concentrator, with about 77% of the concentrator feed first processed in leaching tanks to recover acid-soluble copper. The combined production from in-plant processed ore in the form of concentrates, precipitates, and electrowon cathodes was 34,263 tons of copper. Waste dump leaching of mined material too low in copper content for in-plant treatment yielded an additional 10,633 tons of copper. At the Ox Hide mine, 2.3 million tons of ore was mined for heap-leaching dumps and 5,053 tons of copper was recovered in the form of precipitates. At the Christmas open pit mine, southeast of Miami, Ariz., output was 5,865 tons from processing 1.4 million tons of ore and removal of 4.8 million tons of waste. Total mine production from all operating mines was 55,815 tons of copper compared with 61,238 tons in 1974.

The Cyprus Pima Mining Co. operated the open pit Pima mine near Tucson, Ariz., milling 19.6 million tons of ore averaging 0.48% copper. Delivery of 15 new 170-ton-capacity trucks to replace smaller vehicles and a third 20-cubic-yard shovel for 1976 delivery was expected to improve mine efficiency. Cyprus Bagdad Copper Co. at its Bagdad, Ariz., property mined 2.1 million tons of sulfide ore averaging 0.70% copper. In addition, 7,500 tons of cathode copper produced by a leach-electrowinning process was sold. Progress on a major mine-mill expansion program, designed to handle 40,000 tons of ore per day and planned to be completed by late 1977, included site preparation of the primary crusher and concentrator, and acquisition of 11 of 20 new 170-ton trucks and 1 of 4 20-cubic-yard shovels planned for the operation. Ore reserves at yearend were 300 million tons of proven ore averaging 0.49% copper, with additional tonnages indicated. The Cyprus Bruce Copper and Zinc Co. operated its underground copper-zinc mine near Bagdad, Ariz., and mined 94,600 tons of ore grading 3.7% copper and 12.5% zinc. The Cyprus Johnson Copper Co. completed development of an oxide-copper ore deposit near Johnson, Ariz., and production began in March. The leach-electrowinning process was expected to achieve the rated capacity of 5,000 tons of copper annually as cathodes during 1976. Reserves consist of nearly 13 million tons of oxide ore with 0.50% acid-soluble copper, which assures a life for the operation of about 9 years. An additional 10 million tons of mixed oxide and sulfide ore underlie the oxide deposit.

Ranchers Exploration & Development Corp. produced a record 7,605 tons of copper cathodes by a leaching-solvent extraction-electrowinning process at its Bluebird mine near Miami, Ariz. Lower copper prices and the unfavorable economic climate prompted the company to postpone its planned 50% expansion program. The in situ leaching operation at the Old Reliable deposit near San Manuel, Ariz., and the leaching operation at the Big Mike mine near Winnemucca, Nev., were placed on standby to await higher prices. The curtailed outputs for the year were 735 tons of copper in precipitates at the Old Reliable and 214 tons of copper in precipitates at the Big Mike.

Hecla Mining Co. in a joint venture with El Paso Natural Gas Co. continued mine development and plant construction at the Lakeshore copper mine south of Casa Grande, Ariz. The $195 million project was 95% complete and production was scheduled for early 1976, with output to gradually buildup to 65,000 tons of copper per year. Sulfide ore will be milled in a 11,000-ton-per-day concentrator with the concentrate treated by roasting, leaching, and electrowinning to produce 30,000 tons per year of cathode copper. The roasting operation will produce 200 tons per day of sulfuric acid for use in a 6,000-ton-per-day vat-leaching plant to process oxide ore. The leaching-plant output will be 35,000 tons of copper in the form of precipitate copper.

Operations at the UV Industries, Inc., Continental mine near Bayard, N. Mex., was curtailed by a 3-month strike. Output was 17,614 tons of copper in concentrate from milling 1,644,000 tons of ore averaging 1.17% copper. Reserves at yearend were 18 million tons averaging 0.86% copper suitable for open pit mining and 19 million tons averaging 1.97% copper suitable for underground mining.

Smelter Production.—Output of copper at primary smelters in the United States was 1.50 million tons, a 9% decrease from that of 1974 and the smallest quantity since 1968. The reduced production reflects curtailment of operations as an adjustment to the reduced demand for copper.

ASARCO completed water-control and dust-collection facilities to meet primary water-quality standards and to improve in-plant working conditions at its Tacoma, Wash., smelter. An air monitoring and meteorological measurement system for air quality control was placed in operation at the Hayden, Ariz., smelter. At the El Paso, Tex. smelter, design work began on a second acid plant to collect sulfur emissions from both the copper smelter and the sinter machine of the lead smelter. An agreement was reached with the State of Texas to improve fugitive emissions at ground level by enclosing completely and ventilating the building housing the converter furnaces.

Anaconda completed construction of a fluid-bed roaster and 37,000-kilowatt electric furnace complex in October. The new facility will permit greater recovery of sulfur gases and particulates and replace some of the reverberatory furnace capacity.

In August, Kennecott began operating a supplementary control system for regulating sulfur dioxide emissions at its Hurley, N. Mex., smelter. During the last 5 months of the year, curtailment of smelter operation to meet ambient air quality standards resulted in an average loss of 2 days of operation per month. The McGill, Nev., smelter was shutdown for 8 weeks during the third quarter. One week after resumption of operation, a furnace failure caused an additional 5-week curtailment. At the Garfield, Utah smelter, work continued on an extensive construction project for improved environmental controls to be completed in 1977. Included in the project will be the replacement of existing reverberatory furnaces and converters with a continuous smelting-converting unit developed by Noranda Mines Ltd. and also construction of an additional sulfuric acid plant.

Phelps Dodge essentially completed construction of a new copper smelter in Hidalgo County, N. Mex. Cost of the smelter project, including a townsite and a 36-mile industrial railroad, was estimated at $240 million. It will be the first smelter in the United States to utilize the flash smelting process. Initially, the facility will have the capacity to treat about 1,400 tons of concentrates per day, equivalent to about 100,000 tons of anode copper annually. Agreement was reached to smelt concentrates from the Cyprus Mines Corp. expanded Bagdad, Ariz., mine beginning in 1978, which requires additional construction, including a second acid plant to increase the smelter capacity.

Magma Copper Co. installed equipment and storage facilities at the San Manuel smelter to permit greater use of oil as smelter fuel during periods of natural gas scarcity. However, the increased cost of oil prompted an engineering study and search for an adequate source of coal as an alternative.

Inspiration Consolidated Copper Co. experienced several equipment failures during the first full year of operation of its new electric furnace and acid plant completed in 1974. The most serious problem was failure of the furnace wall in December. However, prior to this failure, both plants demonstrated performances at rated capacities. New copper-bearing material treated at the smelter rose from 248,000 tons in 1974 to 299,000 tons in 1975. The portion supplied from other producers' mines increased from 45% to 64%.

Refined Production.—Production of refined copper from primary materials decreased 13% to 1.44 million tons. Refined copper produced from scrap was 344,500 tons compared with 496,900 tons in 1974. Total production of refined copper in the United States was 1.79 million tons, derived 81% from primary and 19% from scrap sources.

ASARCO completed construction on a new refinery of 420,000 tons of annual copper capacity at Amarillo, Tex., and by yearend was operating at about 50% capacity. Together with the necessary infrastructure and related facilities, the project was estimated to cost on the order of $190 million and will employ 700 people. ASARCO's Baltimore refinery, replaced by the Amarillo refinery, was closed in December as planned.

An expansion project by Anaconda to increase capacity at its Great Falls, Mont., refinery by 38% to 42 million pounds per month was completed during the year. Renovation of the silver slime and solution purification circuits was in progress. General economic conditions and a lack of feed material dictated closure of the company's Perth Amboy, N.J., copper refinery, which for 40 years had been the principal processor of blister and anode copper from Anaconda's Chilean operations.

In the first full year of operation, AMAX produced 5,000 tons of refined copper at its nickel-copper-cobalt refinery at Braithwaite, La. The facility was designed to process nickel-copper matte produced by Bamangwato Concessions, Ltd. (BCL) in Botswana, as well as feed material from other sources. Capacity operation of 23,500 tons of copper per year was scheduled to be attained early in 1977.

Copper Sulfate.—Copper sulfate was produced from primary and/or secondary metal by companies with plants located as follows:

Company	Plant location
The Anaconda Company	Great Falls, Mont.
Chevron Chemical Co	Richmond, Calif.
Cities Service Co	Copperhill, Tenn.
Phelps Dodge Refining Corp	Laurel Hill, N.Y.
	El Paso, Tex.
Van Waters & Rogers Inc	Wallace, Idaho.

Copper sulfate production decreased 15% to 35,614 tons, the smallest quantity since 1971. Production exceeded shipments plus consumption by producing companies by 3,792 tons, and ending stocks of 6,866 tons were the highest yearend level since 1970. Of the total 31,822 tons shipped, producers' reports indicated that 16,187 tons was for agricultural uses, 15,119 tons was for industrial uses, and 516 tons was for other uses.

Byproduct Sulfuric Acid.—Sulfuric acid was produced at 12 copper smelters from the sulfur contained in offgases, and output increased for the eighth consecutive year, from 1,277,400 tons to a record 1,784,700 tons, on a 100%-acid basis. A sulfuric acid plant was under construction at the new Hidalgo County, N. Mex., smelter. Work was suspended on construction of an acid plant at the McGill, Nev., smelter pending resolution of a disagreement between the company and the Environmental Protection Agency over interpretation of applicable clean air standards.

SECONDARY COPPER AND BRASS

Domestic recovery of copper in all forms from all classes of purchased scrap totaled 971,965 tons in 1975, a 28% decrease from the 1974 total. Recovery from copper-base scrap declined from 1.32 million tons to 946,176 tons. Brass mills accounted for 43% of the recovered copper, primary producers for 29%, and secondary smelters for 23%. The remaining 5% was reclaimed at chemical plants, foundries, and manufacturers.

Consumption of purchased copper-base scrap in 1975 was 1.25 million tons consisting of 61% new scrap and 39% old scrap. Of the major categories of copper and copper-alloy products derived from scrap, the output of unalloyed copper, brass mill products, and brass and bronze ingots were 355,500 tons, 510,400 tons, and 188,200 tons, respectively.

CONSUMPTION

Consumption of refined copper dropped 30% to 1.53 million tons, a decrease for the second consecutive year and the smallest quantity since 1961. The reduced level of consumption was a reflection of the slump in construction, automobile production, and other areas of the economy which consume copper. Wire mills accounted for 69% of refined copper consumption, brass mills for 29%, and all other categories for the remaining 2%.

Apparent withdrawals of primary refined copper on domestic account was 1.31 million tons compared with 1.78 million tons in 1974, the latter figure excluding the supply component of approximately 252,000 tons released from the Government stockpiles in 1974.

STOCKS

Stocks of refined copper at primary producers increased from 101,000 tons at the start of the year to 225,000 tons by the end of June and were 207,000 tons at yearend. This was the largest yearend stock level since 1934. At wire rod mills, brass mills, other refined copper consumers, and secondary smelters there was a small increase in refined copper stocks from 150,900 to 156,100 tons during 1975. Refined copper stocks reported by the New York Commodity Exchange (COMEX) rose from 43,200 to 100,000 tons.

PRICES

The domestic price for refined cathode copper was established at 68 cents per pound on January 2, following an initiating reduction from 72 cents by one producer on December 27, 1974. A 5-cent price cut to 63 cents was effective February 1 for all producers. Between mid-June and late July, two producers decreased their quotes to 60 cents per pound but then returned to the 63 cents maintained by the others throughout the remainder of the year. Electrolytic wire bar quotations were 0.625 cent to 2 cents above quotations for cathode copper. Average quoted prices for electrolytic wire bar copper was 64.2 cents per pound for 1975 compared with 77.3 cents for 1974.

Prices on the London Metal Exchange (LME) increased from a monthly average of 54.9 cents per pound for January to 60.9 cents for March then declined to 52.2 cents for December. The average for the year was 56.1 cents compared with the record high 93.1 cents for 1974.

FOREIGN TRADE

Net imports of copper were a relatively small supply component in 1975 as imports of unmanufactured copper, excluding alloyed copper scrap, were 324,100 tons compared with 608,600 tons in 1974 while exports increased from 191,200 to 233,900 tons. Refined copper, the largest trade category, showed a net export quantity as imports dropped from 313,600 to 146,800 tons while exports advanced from 126,500 to 172,400 tons. Imports of blister copper were 89,000 tons compared with 207,800 tons in 1974. The other import categories of ore, concentrates, matte, and unalloyed copper scrap totaled 88,400 tons; the other export categories of ore, concentrates, matte, blister, unalloyed scrap, and ash and residues totaled 61,500 tons.

Exports of alloyed copper scrap, in gross weight, were 99,200 tons compared with 118,200 tons in 1974. Imports of alloyed copper scrap were 9,000 tons, gross weight, or 5,800 tons, copper content.

WORLD REVIEW

World mine production of copper dropped to 7.68 million tons in 1975, a decrease of 5%. The recession generated drop in demand, low prices and high operating costs led to production decreases of up to 15% in several of the major individual copper-producing countries. A notable exception of this trend was Poland, where a copper mine output increase of 36% moved Poland from 10th to 7th largest producer in the world. The United States continued to lead the world in mine production with 18% of the total, followed by Chile 12%, the U.S.S.R. 11%, Canada 10%, Zambia 10%, Zaire 7%, Poland 4%, the Philippines 3%, Australia 3%, Peru 2.6%, and the Republic of South Africa 2.6%.

World stocks of refined copper, as reported by the World Bureau of Metal Statistics, accumulated dramatically from 953,000 tons at the beginning of the year to 1,719,000 tons to yearend representing an increase of 80% over 1974 and 151% over 1973. The stocks included producer, consumer, and merchant inventories of 511,000 tons (including 100,000 tons in COMEX warehouses) of refined copper in the United States, 329,000 tons in Japan, 205,000 tons combined between West Germany, France, and the United Kingdom, plus 548,000 tons held in LME warehouses. The LME stocks, valued at over $600 million, have served as a key market indicator, increasing over fourteen-fold from the 1973 prerecession level of 38 tons. The total world stock level represented the equivalent of a 3.5-month demand based on the average monthly western-world consumption of refined copper of 490,000 tons in 1974 or a 2.7-month demand based on the 1973 peak consumption level of 638,000 tons monthly.

In response to market conditions, the conference of Ministers of the Conseil Intergouvernemental des Pays Exportateurs de Cuivre (CIPEC), comprised of Chile, Peru, Zaire, and Zambia, met in an extraordinary seventh session in Paris, April 9–11, 1975. The decision was made to reduce copper production by 15% from April 15, 1975, and to increase export cutbacks from 10% to 15% at the same date. At the eighth annual conference of CIPEC ministers held in Lima, Peru, November 18–20, 1975, it was decided to continue the cutbacks until June 30, 1976. During the meeting, Indonesia was formally admitted as a new full member and Australia and Papua New Guinea were admitted as nonvoting associate members. As a result, CIPEC claimed to control 38% of mine production, and over 72% of internationally traded copper. Major policy decisions announced at the conclusion of the conference included a CIPEC proposal to initiate a dialogue between producing and consuming countries with a view toward negotiating a copper price stabilization agreement.

Argentina.—Cía. Minera Aguilar S.A., the Argentina subsidiary of St. Joe Minerals Corp., continued engineering and feasibility studies on the Pachon porphyry copper deposit and increased the size of reported ore reserves to 790 million tons of 0.59% copper and 0.016% molybdenum. Potential production in 1981 is dependent on the arrangement of financing.

Australia.—The Australian copper industry, hard hit by high wage and cost inflation and low copper prices, dropped mine output 13% to 241,000 tons; refined copper production increased 2% to 182,300 tons in 1975. The industry had appealed to the Government through the Industries Assistance Commission to provide assistance that would allow unprofitable producers to remain in operation until copper prices recovered. Delayed by the December elections and the resulting change in government, no action had been taken by yearend.

Mount Isa Mines Ltd., operated its copper-lead-zinc-silver mine at Mount Isa and a copper smelter at Townsville to produce a record 175,000 tons of blister copper for the fiscal year ended June 30, 1975. This output exceeded the rated productive capacity of 170,000 tons, which was the result of the expansion program completed in 1973.

The Mount Lyell Mining & Railway Co., Ltd., a subsidiary of Consolidated Gold Fields Ltd., for the year ended June 30, 1975, increased production 2% to 27,350 tons of copper in concentrate from 2.32 million tons of ore grading 1.24% copper, mined and milled at its Queenstown, Tasmania, operation. Ore production came 90% from underground operations. Reserves in all ore zones were estimated at 31.7 million tons of proven ore grading 1.5% copper and 11.4 million tons of probable ore grading 1.42% copper.

Gunpowder Copper Ltd., owned 48% by Consolidated Gold Fields and located 80 miles north of Mt. Isa, increased production 4% to 8,046 tons of contained copper. A development program was underway to double capacity to 600,000 tons of ore annually by late 1978. Reserves at Gunpowder's Mammoth mine were 8.8 million tons grading 3% copper.

Cobar Mines Pty., Ltd., owned by BH South Ltd., treated 666,300 tons of ore averaging 1.9% copper producing 10,700 tons of copper contained in 42,800 tons of concentrates. The severe economic conditions led to an announcement to cut the rate of production from 800,00 to 500,000 tons per year and to suspend all development work. Drilling prior to this decision, however, increased ore reserve estimates at the CSA, Chesney, and Gladstone ore bodies to 44 million tons. Previous estimates reported average reserve grades of 1.0% copper and 4.4% zinc.

Kanmantoo Mines Ltd., in Kanmantoo, South Australia, also held by BH South Ltd., decreased production for the fiscal year ended June 30, 1975, 16% to 6,626 tons of copper contained in 32,700 tons of concentrates recovered from 967,000 tons of copper ore milled. Due to increasing losses, BH South announced that the Kanmantoo mine would be closed in mid-1976.

Peko-Wallsend Ltd., operated the

copper-gold mine at Mount Morgan, Queensland, and the Tennant Creek copper-gold-bismuth mines in the Northern Territory. At the Tennant Creek operations, the suspension of all copper mining and smelting activities continued throughout the year. The smelter was to be kept on a care and maintenance basis through 1976. Copper production for the fiscal year ended July 8, 1975, decreased 40% to 9,800 tons. The production figures represent a full rate of production for July-December 1974, and production of byproduct copper only from the mining of gold shoots within the Juno, Peko, and Warrego mines for January–June 1975. During the 1974–75 fiscal year, Mount Morgan produced 9,100 tons of contained copper in 1.4 million tons of ore treated. Remaining reserves were estimated at 2.2 million tons grading 0.62% copper. The smelter handled 82,700 tons of concentrate feed yielding an output of 9,530 tons of blister copper. Decreasing ore grades and a major slide in the open pit in November led to a yearend decision to close down one of the two mills at Mount Morgan.

Botswana.—Bamangwato Concessions, Ltd. (BCL), operated the Pikwe open pit and underground nickel-copper mine and flash smelter and continued development work on the Selebi underground ore body. Production at Selebi must be phased in to offset the depletion of the open pit during 1979. Modifications and improvements to the plant process control areas, designed to remove production bottlenecks, were scheduled for completion by late 1976. Ownership of BCL is 15% by the Government of Botswana and 85% by Botswana Roan Selection Trust, Ltd. (BRST), which in turn is owned 40% by the public and about 30% each by AMAX and the Anglo American Corp./Charter Consolidated, Ltd. Group.

During the year, ore milled increased 41% to 1,267,500 tons grading 1.15% nickel and 0.94% copper compared with 901,300 tons grading 1.18% nickel and 1.01% copper in 1974. Production of a 75% to 80% copper-nickel matte improved from 7,345 tons to 18,200 during the year, but was still below the 50,000-ton planned capacity. The matte product was shipped to AMAX's Port Nickel, La., plant for refining. The 16,553 tons of matte processed yielded 5,000 tons of nickel and 6,582 tons of copper.

Canada.—Mine production decreased 12% in 1975 to 798,132 tons of recoverable copper. Smelter output decreased 7% to 551,150 tons, and refinery production decreased 5% to 583,350 tons of copper. Mine production decreased in nearly all Provinces in 1975 except for New Brunswick and Newfoundland. Ontario moved ahead as the leading copper-producing Province with 37% of the total, followed by British Columbia 33%, Quebec 16%, Manitoba 9%, and the remaining Provinces 5%.

In 1975, the double burden of Federal and provincial mining tax and royalty levies were an important added factor in delaying new copper expansion and mine development programs in Canada. Changes announced or being discussed in the second half of the year indicated the mining industry could expect some easing of restrictive taxes in 1976. In particular, the Federal Government introduced a new "Resource Allowance" deduction amounting to 25% of resource production profits after the deduction of operating and capital costs. The Resource Allowance recognizes and allows for a limited deduction of provincial resource taxes and increases the tax value of incentive write-offs, such as exploration and development costs. In British Columbia, the election of a new Social Credit Government in December was expected to bring changes in the mining tax and royalty legislation, which left most mines with little or no profits in 1974 and 1975. In Manitoba and Saskatchewan, legislation passed during the year gave the provincial Governments authority to participate directly in exploration and development projects. The Yukon and the Northwest Territories, with no restrictive mining tax legislation, saw increased exploration activity relative to the other Provinces. There was also a trend, particularly in Ontario and Quebec, to provide incentives to attract an increased degree of mineral processing, smelting, and refining within the Provinces.

In British Columbia, Afton Mines Ltd., controlled 54% by Teck Corp. Ltd., announced plans in October for the only new major copper development in the Province in 1975. The $80 million mine, mill, and smelter complex will have a capacity of 25,000 tons per year of copper with construction scheduled for completion in late 1977. The smelter will be the first copper smelter to employ the new top-blown rotary-converter (TBRC) process developed by International Nickel Co. of Canada, Ltd. (INCO) and Dravo Corp. The Afton property is located only 8 miles west of Kamloops, British Columbia, on the route of the Trans Canada Highway and electric power and pipelines, which must be moved to develop the mine. The complex syenite porphyry deposit contains 34 million tons of open pit ore grading 1% copper. The heavily oxidized portion of the ore body above 500 feet is rich in native copper, which is expected to concentrate to a low-sulfur-bearing, high-grade 60%-copper product. Under an incentive program to encourage the construction of copper smelters in the Province, the British Columbia Government will provide Afton with payment of 2 cents per pound of copper produced from the smelter during its first 4 years of operation. The Province also has an option to purchase, at cost, a 5% joint-venture interest in the smelter unit, exercisable for a period of 1 year after completion of the project.

Bethlehem Copper Corp., Ltd. milled 6.5 million tons of ore grading 0.47% copper from open pit mines in the Highland Valley, and produced concentrates containing 27,300 tons of copper compared with 28,500 tons in 1974. Reserves at the operating Huestis, Iona, and Jersey mines total 56 million tons of 0.46% copper. Negotiations were underway regarding the feasibility of bringing into production the 900-million-ton 0.48%-copper ore body of Valley Copper Co., in which Bethlehem has a 20% interest. Development of the Maggie ore zone, north of Highland Valley, with indicated reserves of 200 million tons of 0.40% copper equivalent, was also delayed.

The Granduc mine of Granduc Operating Co., north of Stewart, British Columbia, operating at 60% of capacity, produced 18,700 tons of copper in concentrate from 1.6 million tons of ore grading 1.20% copper. Granduc deferred underground development work needed to make more ore available for mining after 1977. Reserves at yearend were 19.6 million tons of 1.69% copper. Engineering studies were being made to determine the feasibility of mining an estimated 11 million tons of 1.50% copper below the 2,100-foot level.

Lornex Mining Corp. Ltd., controlled by the Rio Tinto-Zinc Corp. Ltd., operated an open pit copper-molybdenum mine in the Highland Valley and produced 53,569 tons of copper and 1,542 tons of molybdenum in concentrate from 12.9 million tons of ore.

The Bell Copper Div. of Noranda Mines Ltd., in Granisle, British Columbia, mined 4.8 million tons of ore grading 0.46% copper in 1975. Concentrate output of 69,760 tons contained 18,150 tons of copper. Reserves decreased to 29.6 million tons of 0.49% copper and 0.012 ounce of gold per ton.

Brenda Mines Ltd. (50.9% Noranda), located in Peachland, British Columbia, operating one of the lowest grade porphyry copper-molybdenum mines in the world, produced a record 10 million tons of ore averaging 0.188% copper and 0.052% molybdenum yielding 16,600 tons of copper in concentrates. The initial 5-year contract with Japanese smelters was not renewed, and since mid-1975 copper concentrate was sold to North American smelters. Yearend reserves were 126 million tons of 0.176% copper and 0.047% molybdenum.

Placer Development Ltd. (33% Noranda) operated the Craigmont mine in Merritt, British Columbia, and the Gibralter mine in McLeese Lake, British Columbia, during the year. At the Gibralter mine 11.5 million tons of ore grading 0.43% copper were milled. Production of copper in concentrates was reduced 7% to 41,780 tons in response to smelter requests and the harder ore coming from the Granite Lake pit. Reserves decreased to 308 million tons, with an average grade of 0.35% copper. At Craigmont 1.97 million tons of ore grading 1.42% copper was milled. The 91,100 tons of concentrates produced contained 26,813 tons of copper, an increase of 23% over strike-affected 1974. Ore reserves of 7 million tons of 1.83% copper were sufficient to maintain operations at the 1975 level for 3 to 4 years.

Similkameen Mining Co. Ltd., a subsidiary of Newmont Mining Corp., operated its open pit mine near Princeton, British Columbia. Seriously affected by equipment problems and a 9-week strike, output for the year decreased 23% to 16,300 tons of copper in concentrate from milling 4.1 million tons of 0.46% copper ore. Expansion of the concentrator, from 15,000 to 22,000 tons of ore per day, was completed in September 1975 to permit milling an additional 7,000 tons per day of material grading about 0.25% copper. Ore reserves at yearend were estimated at 58.2 million tons averaging 0.53% copper.

Utah International Inc., rebounding from the 1974 strike, shipped approximately 58,000 tons of copper and 62,000 ounces of gold in concentrate from its Island Copper mine on the northern end of Vancouver Island in British Columbia. The mill treated 13.7 million tons of ore in 1975.

In Manitoba, Hudson Bay Mining & Smelting Co. Ltd., operated nine mines and one smelter in the Flin Flon-Snow Lake area. Approximately 1.47 million tons of ore with an average grade of 2.4% copper and 3.0% zinc were mined and milled to produce 198,308 tons of a 16.48% concentrate containing 32,680 tons of copper, a decrease of 5%. The copper smelter produced 65,445 tons of anode copper from feed supplied 48% from Hudson Bay mines and 52% from purchased concentrates. Development work continued on the new Centennial and Westarm mines with both shafts down to over 1,400 feet at yearend. High costs shutdown the Dickstone mine in August, while depletion of developed ore reserves was expected to shutdown the Schist Lake and White Lakes mines in 1976. Total ore reserves at yearend were about 17.5 million tons grading 2.77% copper, 2.8% zinc, 0.033 ounce of gold per ton, and 0.52 ounce of silver per ton.

Sheritt Gordon Mines, Ltd. operated the Fox, Lynn Lake, and Ruttan Lake mines in Manitoba with a combined output of 43,400 tons of copper in concentrates compared with 50,800 tons in 1974. Copper production was down 11% to 27,470 tons at the Ruttan open pit mine, in which 3.34 million tons of ore averaging 0.96% copper and 1.90% zinc were milled. The lower Ruttan output was attributed to high pit equipment downtime and pit slope instability problems. At the Fox underground mine, 1.0 million tons of ore averaging 1.74% copper and 1.81% zinc were milled with production of copper in concentrates decreasing 20% to 15,747 tons. Output at the Lynn Lake nickel-copper mine continued below expectations, with copper in concentrates decreasing 20% to 2,366 tons. At yearend, production plans called for reducing output by 25% at both the Fox and Ruttan mines.

The Ontario-based Falconbridge Nickel Mines Ltd. delivered 59,260 tons of copper from nine nickel-copper mines in Sudbury, Ontario, and Manibridge, Manitoba, and from five copper-zinc, copper, and iron-copper mines in Lake Dufault and Opemiska, Quebec, Sturgeon Lake, Ontario, and Tasu Harbor, British Columbia. Concentrates from the nickel-copper operations were processed at the company smelter in Sudbury and from the other copper-zinc operations at the Noranda Mines Ltd. smelter at Noranda. Due to a 10-week labor strike at Sudbury that ended on November 2, deliveries of copper from the integrated nickel operations decreased 25% to 20,357 tons. Following the strike, production was resumed at 70% of the prestrike level, as three mines, one mill, and one of two blast furnaces were shutdown and placed on standby status. Ore reserves at yearend at Sudbury and Manibridge were 89.1 million tons averaging 1.43% nickel and 0.68% copper.

Deliveries of copper from Falconbridge Copper Ltd. increased 32% to 38,900 tons as the new Sturgeon Lake Mines Ltd. began full production on February 1. The $20 million Sturgeon Lake project, with a rated capacity of 1,200 tons per day of ore, produced 7,960 tons of copper for the year. Ore reserves at yearend were calculated at 1.8 million tons grading 2.85% copper, 10.28% zinc, 1.36% lead, 5.66 ounces of silver per ton, and 0.022 ounce of gold per ton.

INCO mined 21.2 million tons of ore with an average grade of 1.40% nickel and 0.92% copper from 16 mines in Ontario and Manitoba in 1975, compared with 22 million tons of ore with an average grade of 1.39% nickel and 0.97% copper in 1974. Deliveries of copper metal from the Copper Cliff refinery decreased 9% to 167,275 tons. At yearend, INCO estimated that proven ore reserves in Canada were 415 million tons, containing 1.61% nickel and 1.04% copper. In December, production at the Victoria mine was suspended to allow the undertaking of a yearlong redevelopment program. The small Kirkwood ore body was nearly mined out and expected to close in early 1976. Development work on the new Levack East mine at Sudbury began during the year with startup scheduled for 1984.

At Mattagami Lake Mines Ltd. Mattabi mine in northwestern Ontario, the concentrator treated 1.08 million tons of ore grading 0.97% copper yielding 8,700 tons of contained copper in concentrate. Ore reserves were 9.9 million tons of 6.70% zinc, 0.74% copper, 0.70% lead, 2.62 ounces of silver per ton, and 0.007 ounce of gold per ton. Development work on Mattagami's new underground mine at Lyon Lake, in the Sturgeon Lake area, continued with initial production of 1,000 tons per day of ore scheduled to begin in 1978. Reserves at the Lyon Lake deposit were increased to 4.03 million tons of 6.66% zinc, 1.15% copper, 0.63% lead, 3.39 ounces of silver per ton, and 0.010 ounce of gold per ton.

The Geco Division of Noranda Mines Ltd., at Manitouwadge, Ontario, produced 1.6 million tons of ore grading 1.84% copper, 3.54% zinc, and 1.44 ounces of silver per ton. Concentrates produced contained 27,400 tons of copper, a decrease of 6%. Reserves at yearend were 28.1 million tons grading 1.87% copper, 3.62% zinc, and 1.52 ounces of silver per ton.

Texasgulf Canada Ltd. operated the Kidd Creek mine near Timmins, Ontario, and mined 3.63 million tons of ore in 1975, down 2% from 1974. Production was about 63% from the open pit and 37% from underground. The mine yielded 228,800 tons of a 25%-copper concentrate and 9,600 tons of a copper-silver concentrate during the year, representing only a 1% drop in production for the year. At the end of 1975, measured and indicated reserves above the 2,800-foot level were estimated at 86 million tons containing 2.70% copper, 5.92% zinc, 2.31 ounces of silver per ton, and 0.217% lead. An additional 6 million tons was classified as inferred ore. Texasgulf was proceeding with a $100 million project to increase the mine production rate from 3.6 to 5.0 million tons per year by adding a fourth 3,500-ton-per-day circuit to the concentrator and by constructing a mile-deep shaft to develop the lower portion of the ore body. An agreement was signed in mid-1975 with the Mitsubishi Metal Corp. of Japan for the process license and basic design of a continuous copper smelter and mechanized copper refinery. This system was reported to be the most environmentally sound and lowest cost pyrometallurgical copper-smelting process in existence. At an estimated cost of ov $250 million, the facility was scheduled for a late 1978 startup with an initial 100,000-ton-per-year capacity, later expanding to 130,000 tons per year. A gold, silver, and selenium slimes-processing refinery was also to be built.

Union Minière Canada Ltd., continued development of its Thierry copper deposit in the Pickle Lake, Ontario region with planned production for the second half of 1976 at an annual rate of 1.4 million tons of ore milled. Initial output will be from two small open pits, to be followed by underground mining. Proven reserves amounted to 15 million tons averaging 1.63% copper and exploration work in progress indicated further potential.

In the Northwest Territories, Texasgulf reported the discovery of an important base-metal sulfide deposit at Izok Lake, 225 miles north of Yellowknife. Drilling at the central of three zones showed 7 million tons of indicated ore containing 3.15% copper and 14.8% zinc.

In Quebec, Campbell Chibougamau Mines Ltd. failed to negotiate a new labor contract and suspended operations on May 5, 1975, accounting for the 48% decrease in copper production to 6,160 tons. Reserves remaining in the Chibougamau area mines total 10.3 million tons grading 1.72% copper and 0.045 ounce of gold per ton.

The Lake Dufault Division of Falconbridge Copper Ltd., in 1975, produced 13,084 tons of copper in concentrate. The 7% increase in production over that of 1974 was attributed to a higher grade of ore treated. Reserves at yearend were 1.86 million tons of ore grading 3.56% copper and 4.62% zinc. The Opemiska Division milled 952,000 tons of 2.02% copper in 1975 to produce 18,383 tons of copper in concentrate. Remaining reserves consist of 5.69 million tons of 2.39% copper. Shaft sinking at the Cooke mine was completed and development was in progress.

Madeleine Mines, near Ste. Anne des Monts, Quebec, milled 908,000 tons of copper yielding 9,677 tons of copper. Approximately a 4-year supply of reserves remained.

Noranda Mines Ltd. had an interest in the treatment of 49.5 million tons of ore containing 216,300 tons of contained copper from 19 copper and zinc-copper mines in Quebec, British Columbia, Ontario, and New Brunswick. Shortages of skilled miners continued to hamper a number of Noranda's operations during the year. The company's two copper smelters at Noranda, Quebec, and Gaspé Copper in Murdochville, Quebec, treated 879,700 tons of concentrates from Noranda operations and 839,500 tons of custom material from other Canadian copper mines and from overseas. The 1.7 million tons of total material treated yielded 304,200 tons of copper contained in anodes for a decrease of 10% from that of 1974. The Noranda smelter accounted for 76% and Gaspé 24% of anode production. Canadian Copper Refineries, Ltd. (CCR) in Montreal East, Quebec, operated by Noranda, is one of the world's largest copper refineries, with a rated annual capacity of 480,000 tons. In 1975, refinery production decreased 7% to 395,000 tons of copper. CCR processed the output of the Noranda smelters, the Flin Flon smelter of Hudson Bay Mining & Smelting Co. Ltd., and imported and secondary material.

Noranda's Horne Division in Noranda, Quebec, produced 344,300 tons of ore averaging 2.15% copper and 0.135 ounce of gold per ton. Reserves of 231,000 tons of 1.05% copper at the Horne mine were expected to be depleted by 1976.

Gaspé Copper Mines Ltd. (Noranda) milled 1.25 million tons of 1.19% copper ore from the Needle Mountain mine and 9.75 million tons of 0.44% copper ore from Copper Mountain mine yielding 48,000 tons of copper contained in concentrates. Reserves at the two mines were, respectively, 21.6 million tons of 1.33% copper and 201 million tons of 0.38% sulfide copper plus 33 million tons of 0.45% oxide copper.

Mattagami Lake Mines Ltd. (43% Noranda) treated, at the Mattagami Lake mine, 1.29 million tons of ore averaging 7.3% zinc, 0.62% copper, 0.86 ounce of silver, and 0.014 ounce of gold per ton, which yielded 6,000 tons of copper in concentrate. Remaining ore reserves totaled 10.8 million tons grading 8.4% zinc, 0.65% copper, 0.95 ounce of silver per ton, and 0.015 ounce of gold per ton.

Patino Mines (Quebec) Ltd., a subsidiary of the Dutch company Patino, N.V., operated or had an interest in five copper-gold mines in Quebec. Affected by a strike for the first 3½ months of 1975 and by the temporary shutdown of the Copper Cliff, Jaculet, and Portage mines, total mill production of 440,000 tons of 1.67% copper was down from the 1974 input of 859,000 tons of 1.56% copper. Metal production derived solely from the Copper Rand mine amounted to 6,900 tons of copper in concentrate, down 45% from 1974. Ore reserves at yearend were 6.2 million tons of 1.74% copper and 0.055 ounce of gold per ton. The associated company, Lemoine Mines Ltd., nearly completed its $8.6 million, 400-ton-per-day mine and mill complex, 37 miles southeast of Chibougamau, with startup scheduled for March 1976. The high-grade volcanogenic massive sulfide deposit contains reserves of 625,000 tons of 4.5% copper, 10.8% zinc, 2.7 ounces of silver per ton, and 0.138 ounce of gold per ton.

In the Yukon Territory, Whitehorse Copper Mines Ltd., owned in part by Hudson Bay and Anglo-American Corp. of Canada Ltd., mined and milled 739,000 tons of 1.51% copper ore and produced 27,700 tons of a 36% concentrate containing 9,972 tons of copper. Development work below the 1,750-foot level continued.

Chile.—Mine production for the year decreased 8% to 913,000 tons of copper as Chile continued as the world's second largest copper producer behind the United States. Production from the large mines was as follows: Chuquicamata, 335,800 tons compared with 393,200 tons in 1974; El Teniente, 257,900 tons compared with 248,500 tons; El Salvador, 89,600 tons compared with 88,200 tons; and Andina, 68,800 tons compared with 75,400 tons. Approximately 30,000 to 35,000 tons of the production decrease was accounted for by the closure of the high-cost Exótica mine for the year.

In the medium and small mine production area, Mantos Blancos decreased output 9% to 32,200 tons, Empresa Nacional de Minera (ENAMI) increased output 9% to 85,500 tons, and Disputada raised production 26% to 35,900 tons of copper.

Minera Sagasca, S.A. controlled 59% by Continental Copper & Steel Industries Inc., operated at 30% of capacity for the year and produced 6,000 tons of copper. Sagasca, due to poor oxide leach recovery rates and difficulties in meeting long term debt schedules, applied to the Chilean Government to suspend operations at yearend.

Production of blister copper at Chile's six smelters remained at 798,000 tons, the same as in 1974. Electrolytic and fire-refined copper output remained essentially constant at 590,000 tons. In 1975, Chile exported 776,000 tons of copper contained in all classes valued at US$854 million. Corporación del Cobre de Chile (Codelco) invested approximately $115 million to maintain installed capacity and to lower production costs, which during the year dropped from 51 cents to 48 cents per pound of copper. The expenditures included the expansion of the secondary grinding plant and a new molybdenum recovery plant at Chuquicamata, and an addition of the third reverberatory furnace, and expansion of the Rancagua foundry at El Teniente.

At Codelco's Andina mine, Cerro Corp. was engineering an $18 million project to expand mill capacity to produce 86,000 tons of contained copper by 1978.

Sociedad Minera Pudahuel CPA, owned by private Chilean interests, hired the U.S. firm, Holmes and Narver, as engineer and construction manager for the $40 million Lo Aguirre project near Santiago. The mine, mill, solvent extraction, and electrowinning plant complex is scheduled to start production in 1978 at an annual capacity of 22,000 tons of cathode copper. The Lo Aguirre deposit contained reported reserves of 10.4 million tons of 2.12% copper.

Of the four large ore bodies being made available for foreign exploitation under the Foreign Investment Law (DL–600) of July 1974, Noranda Mines Ltd. signed a letter of intent on Andacolla, located in Coquimbo Province, with reserves of 193 million tons of 0.75% copper and 0.15% molybdenum. Leon Tempelsman & Sons signed one for El Abra, with a minimum 770 million tons grading 0.9% copper, while the other two, Quebrada Blanca and Los Pelambres, were still in an earlier phase of negotiations.

Codelco published *El Cobre Chileno–1975,* a comprehensive 500-page book that gave a detailed property-by-property account of all aspects of the Chilean copper industry. The book reported the magnitude of Chile's copper resources at 10.2 billion tons of 1.02% copper, demonstrated and inferred reserves, plus an additional 7.3 billion tons of identified subeconomic resources averaging 0.32% copper.

Finland.—Copper output increased 7% to 42,770 tons. Principal producing mines, operated by Outokumpu Oy, were the Keretti with 14,000 tons, the Vuonos with 8,260 tons, the Pyhasalmi with 4,970 tons, the Hammaslahti with 4,420 tons, and the Vihanti with 3,620 tons.

France.—The French Government committed over $55 million during the year to establish a raw materials stockpile chiefly to purchase copper and nickel to minimize the impact of price fluctuations on domestic industries. The copper stockpile, managed by the Groupement d'Importation et de Repartition des Metaux S.A. (GIRM), is reportedly maintained at a level sufficient to cover a 2-month consumption. In 1975, refined-copper consumption in France averaged 34,000 tons per month.

Indonesia.—Freeport Indonesia, Inc., a subsidiary of Freeport Minerals Co., and operator of the 11,500-foot-high Gunung Bijih (formerly Ertsberg) copper mine in Irian Jaya, produced 68,500 tons of copper contained in 219,600 tons of concentrates, a decrease of 4% from that of 1974.

Freeport Indonesia Inc. was continuing to study the feasibility of maximizing recovery of ore by open pit mining and to appraise possibilities for underground operations. Present estimates project depletion of the mine's remaining open pit reserves between 1981 and 1983. In late 1975, the Government accepted, in principle, a plan to acquire an 8.5% interest in Freeport Indonesia, reducing Freeport's equity in Freeport Indonesia to slightly over 80%.

Iran.—Sar Cheshmeh Copper Mining Co., an Iranian Government-owned company, continued development of the copper mine and metallurgical complex in southern Iran. Design capacity of the $500 million complex is approximately 160,000 tons of copper per year with initial production scheduled for mid-1977. Anaconda, which is developing and operating the project under a technical assistance contract, reported reserves, at a 0.40% cutoff and to a depth of 500 feet, at nearly 500 million tons of ore averaging 1.13% copper and 0.03% molybdenum.

Israel.—Timna Copper Mines Ltd., operating one of the world's highest cost copper mines with a capacity of around 14,000 tons per year, ceased operations at yearend.

Japan.—Mine production of copper from the Kuroko deposits of Japan, increased 3% to 93,000 tons. Mine output contributed only 10% of the consumption of refined copper since Japan was dependent on imports for about 90% of its copper requirements. The continued recession and high cost of petroleum imports were reflected in the 14% decrease in blister copper production to 905,500 tons and the 18% decrease in refined copper output to 902,400 tons. Based on sales of refined copper, Mitsubishi Metal Corp. was the leading copper company providing 25% of the copper supply, followed by Nippon Mining Co. Ltd. (22%), Mitsui Mining & Smelting Co. Ltd. (15%), Sumitomo Metal Mining Co. Ltd. (15%), The Dowa Mining Co. Ltd. (14%), Furukawa Mining Co. Ltd. (8%), and Toho Zinc Co. Ltd. (1%).

Japan, the world's third largest consumer of refined copper, following the United States and the U.S.S.R., consumed 888,700 tons of copper, a decrease of 3% from 1974 and 33% from the 1973 record.

Restricted by the Ministry of International Trade and Industry (MITI) ban on exporting copper, in effect the full year, producers built-up stock levels at yearend to 207,000 tons, up 76% over 1974 and over 250% above 1973 levels. An additional 122,000 tons of stockpiled copper was held by Japanese merchants and consumers. At yearend, the Japanese cabinet approved approximately $100 million to fund a nonferrous stockpiling program beginning in April 1976. The Government was considering an industry request to establish the copper stockpile at a 90,000-ton level, but the limited funds made this level unlikely.

Mitsubishi, incorporating a significant breakthrough in smelter technology, brought its new Naoshima smelter into full commercial operation in 1975. The new plant, with a design capacity of 4,400 tons of copper per month, is the first commercial plant to use the Mitsubishi continuous copper smelting and converting process.

Malaysia.—The Mamut Mines Development Co., under the management of Overseas Mineral Resources Development Sabah Bhd., a consortium of seven Japanese firms, in a joint venture with the Sabah Government and other Malaysian interests, completed development of the $94 million mine-mill project near Mamut, Sabah. By yearend, technical beneficiation problems were delaying shipments of concentrates from the mill, which is rated at a capacity of 30,000 tons per year of contained copper. The dioritic porphyry and contact serpentinite ore body, discovered by the United Nations in 1965, contains reserves of 196 million tons of ore grading 0.576% copper, chiefly in the form of chalcopyrite.

Mauritania.—The Mauritania Government, which applied for membership in CIPEC, completed arrangements in April with Charter Consolidated Ltd. for the takeover of the Société Minière de Mauritania (SOMIMA) copper mine at Akjoujt. Charter will continue to operate the mine under contract to the Government agency, Société Nationale Industrielle et Minière (SNIM). Production for 1975 was estimated at around 60% of the current capacity of 24,000 tons of copper in concentrate. SNIM announced preliminary plans to build a 33,000-ton-per-year smelter at Akjoujt. Reserves were estimated at 23 million tons of 2% copper.

Mexico.—The Mexican Government passed a new mining law effective February 20, 1975, which among other items increased the compulsory percentage of Mexican capital in mining companies from 51% to 60% when their purpose is to exploit ordinary substances, and from 66% to 75% when their purpose is to exploit substances forming part of the national mining reserve. Mexican copper production decreased slightly in all areas during the year. Mine production dropped 5% to 86,200 tons, smelter output was down 2% to 84,200 tons, and refined copper was down 7% to 69,000 tons.

Industrial Minera Mexico S.A., in which ASARCO has a 34% interest, decreased the output of blister copper 7% to 35,100 tons. Exploration work continued on the large El Arco porphyry copper deposit in the Baja, California peninsula, with reserves now estimated at 770 million tons of about 0.5% copper. Development plans called for the treatment of El Arco concentrates at the proposed new La Caridad refinery complex at Guaymas.

Compañía Cuprifera La Verde, S.A., delayed construction of a $100 million, 27,500-ton-per-year copper project at the La Verde deposit at Gabriel Zamora, Michoacan, 200 miles west of Mexico City. Legal and financing problems postponed the original mid-1975 construction startup. Lytton Minerals Ltd., a Hudson Bay subsidiary, held a 48% interest in the company with the balance shared equally between the Government, Comision de Fomento Minero, and the privately held Mexican company Sociedad de Fomento Industrial, S.A. de C.V.

Compañía Minera de Cananea, S.A., operated the Cananea mine and smelter to produce 44,100 tons of copper compared with 44,400 tons in 1974. Production was hampered by labor problems and some mechanical breakdowns. An expansion program designed to achieve a capacity of 77,000 tons of copper was expected to be completed in 1976.

Cobre de Sonora, S.A. de C.V. was 70% owned by the Mexican Government and Mexican nationals, with the Government intending to acquire the remaining interests, 26.25% held by Anaconda and 3.75% by Phelps Dodge. The company has committed $128 million to develop the Santa Rosa and Pilares copper deposits in the Nacozari region of the State of Sonora with annual planned capacity of 37,000 tons of copper in concentrates.

Mexicana de Cobre S.A., 44% owned by the Mexican Government, continued development of the La Caridad porphyry copper open pit mine in Sonora. The 66,000-ton-per-day mill will be followed by a smelter and refinery complex at the port of Guaymas with a planned capacity of 175,000 tons of copper per year by late 1977. Investment costs increased from $480 to $600 million. Ore reserves were reported at 760 million tons of 0.76% copper and 0.16% molybdenum.

Panama.—The Government of Panama, in a shift in policy, broke off negotiations with Canadian Javelin Ltd. and announced that the Cerro Colorado deposit with reserves estimated at up to 2 billion tons of 0.6% copper would be developed by the Government. On August 27, 1975, the Government signed an agreement to pay Canadian Javelin $5 million in cash plus $18.6 million worth of 8% tax-free, 20-year, Republic of Panama bonds in compensation for exploration and development work already carried out on the property. In July, following open bidding, Panama selected Texasgulf Inc., in an agreement in principle to establish a joint private-Government project to exploit Cerro Colorado at a cost of about $800 million. Texasgulf would receive a 15% to 20% equity interest in the project and be responsible for the evaluation, construction, and operation of the mine.

In the Cerro Petaquilla area of Central Panama, a second major copper deposit reportedly containing an estimated 300 million tons of 0.6% copper was discovered by Cobre Panama, S.A., a consortium of Japanese mining companies.

Papua New Guinea.—On September 16, 1975, Papua New Guinea (PNG) became an independent country. As one of the new CIPEC member countries, PNG with one mine, was the world's 12th largest copper producer in 1975. Copper was expected to play an increasingly important economic role for PNG as the Ok Tedi deposit with reserves of 275 million tons of 0.85% copper and 0.02 ounce of gold per ton, and the Freida River deposit with 400 million tons of 0.45% copper were considered for development. Including a number of additional known copper prospects, this island nation possesses around the 10th largest copper resource base in the world.

Bougainville Copper Ltd., controlled 53.6% by Conzinc Riotinto of Australia Ltd. (CRA), 20% by the PNG Government, and 26.4% by the public, milled 34.3 million tons of a lower grade ore containing 0.64% copper and 0.025 troy ounce of gold per ton. Copper production decreased 6% from that of 1974, owing to the lower head grade with 657,000 tons of a 28.94% copper concentrate or 190,120 tons of contained copper. Estimated ore reserves in the Panguna ore body at the end of 1975 were 915 million tons of ore averaging 0.46% copper and 0.017 troy ounce of gold per ton. Moves for the secession of Bougainville Island from PNG were unresolved at yearend.

Peru.—Affected by the CIPEC agreement to cut production 15% and by large strike-related losses, Peruvian copper mine and smelter production decreased 15% and 11% to 197,340 and 173,081 tons, respectively. Copper exports dropped 30% to 138,900 tons of copper contained in concentrate, blister, and refined products. Refinery production, in contrast, increased 36% to 58,390 tons of electrolytic copper as Empresa Minera del Perú's (Minero Perú) new, $60 million, 165,000-ton-per-year refinery at Ilo came onstream in July, reaching full design capacity in October 1975.

Southern Peru Copper Corp. (SPCC),

Peru's largest copper operation, lost 69 days of production at the Toquepala mine and 26 days at the Ilo smelter due to strikes in 1975. Only 12.2 million tons of 1.06% copper ore were milled compared with 13.5 million tons of 1.24% copper in 1974. Blister copper output decreased to 119,600 tons from 134,400 tons in 1974. On July 1, 1975, SPCC entered into a commercialization agreement with the Government agency Minero Perú Comercial (MINPECO), under which MINPECO will take title to, and market all Toquepala production. Toquepala reserves were estimated at 238 million tons averaging 0.88% copper.

Northern Peru Mining Corp., an ASARCO subsidiary, operated the Quiruvilca mine and produced 6,200 tons of copper in concentrates compared with 7,400 tons in 1974.

Compañía Madrigal, a subsidiary of Homestake Mining Co., processed 235,700 tons of ore, up 20% from 1974, at its Madrigal copper-lead-zinc mine in southern Peru and produced approximately 11,100 tons of copper concentrates, up 4%. Ore grade averaged 1.7% copper, 2.4% lead, and 5.0% zinc. Plans are underway to increase the mill capacity from 770 to 1,100 tons of ore per day.

Most of the approximately 65,000 tons of remaining mine production came from Empresa Minera del Centro del Perú (Centromin), the State-owned mining agency, which operates one open pit and six underground copper mines, including the former Cerro Corp. holdings nationalized in 1974. Centromin is currently undertaking a $46 million expansion of the Cobriza mine and mill to increase capacity to 7,200 tons of ore per day.

Peru has embarked on a major development program to increase copper mine capacity from 245,000 tons to approximately 1,050,000 tons per year. Twelve new copper deposits with combined reserves of over 4 billion tons of ore containing over 27 million tons of copper were in various stages of construction, planning, and feasibility studies. These 12 projects were planned to establish 800,000 tons of new copper capacity at an estimated cost of over $4 billion. From 300,000 to 500,000 tons of this new capacity was expected onstream by 1980 with the remainder dependent on market conditions and financing. In addition, Minero Perú was scheduled to complete the doubling of the capacity of the Ilo refinery to 330,000 tons of electrolytic copper per year by 1977 at a cost of $85 million. Centromin was planning a $52 million project to expand La Oroya refinery capacity from 52,000 tons to 80,000 tons of electrolytic copper.

The major projects included Cuajone (SPCC and Billiton, B.V.), Toro Mocho (Centromin), and Minero Perú's Santa Rosa/Cerro Verde, Michiquillay, and Quellaveco deposits. Construction of the $656 million Cuajone mine, mill, and smelter project was on schedule with startup planned for mid-1976 at an annual capacity of 170,000 tons of blister copper. Cuajone ore reserves were estimated at 470 million tons of 1% copper. Centromin awarded a consortium of Fluor Utah Inc., Furukawa Mining Co. Ltd., Furakawa Electric Co. Ltd., and Mitsui & Co. Ltd., a contract to carry out a feasibility study on the Toro Mocho mine-smelter project, with a design capacity of 90,000 tons per year of blister copper. Located 90 miles east of Lima, Toro Mocho was planned for a 1982 startup at an estimated cost of $730 million. Reserves at Toro Mocho were estimated at 330 million tons of 0.77% copper.

The superjacent Cerro Verde/Santa Rosa deposits contain Peru's largest copper reserves. Cerro Verde, which contains 94 million tons of 0.70% copper, approximately half of which is oxide ore, overlies the giant Santa Rosa sulfide ore body with reserves of 1.3 billion tons of ore averaging 0.55% copper. Engineering work was underway on thr $100 million, first-stage development of the oxide property, a copper mine with an annual capacity of 36,000 tons, scheduled for completion in 1977. The second-stage development of Santa Rosa was to add 182,000 tons of annual copper capacity and include a smelter-refinery complex to be built at Matarani. The project, scheduled for completion in 1980, would cost Minero Perú an estimated $1.3 billion.

Michiquillay, with ore reserves of 650 million tons averaging 0.72% copper, was expected to require $800 million to develop an annual concentrate capacity of 88,000 tons of contained copper by 1980. At Quellaveco, tentative plans called for a $600 million project to produce 80,000 tons of blister copper by about 1980. Reserves were estimated at 440 million tons of ore grading 0.80% copper.

Among the smaller projects, Minero Perú planned to develop the 56-million-ton, 2.0% copper Tintaya deposit. A $100 million mine-mill facility to produce 33,000 tons of copper in concentrates was planned for 1980 or later. Minero Perú, in association with Geomin of Romania, was planning to bring the 91-million-ton, 1.45% Antamina deposit into production in 1978 at a rate of 44,000 tons of copper per year at an estimated cost of $100 million. In the private sector, Mitsubishi Metal Corp. and Compañía Minera De Los Cerros Negros, a Homestake Mining Co. subsidiary, announced discovery of a deposit in the Bronce area near Pashap containing 50 million tons of ore grading 0.8% copper and 0.05% molybdenum. The companies started a feasibility study for a 20,000 to 30,000-ton-per-year operation.

Philippines.—The Philippines maintained eighth rank among world copper producers with 11 mining companies producing 249,900 tons of copper contained in concentrates and direct-shipping-grade ore. Total identified reserves of copper were estimated at 3.85 billion tons of ore with an average grade of 0.48% containing 18.5 million tons of copper. Approximately 60% of the total contained copper is located in developed deposits and 40% is awaiting development. Studies continued on the part of both industry and government on establishing smelter facilities in the country, but no firm decisions had been made by yearend. To assist the depressed industry, the Government removed the 30% premium export duties on byproduct gold and silver on January 1 and the remaining 2% export duty on copper on March 21. To decrease dependence on Japanese smelters, the Philippines began opening new markets for copper in 1975, primarily in the People's Republic of China and Eastern Europe.

Atlas Consolidated Mining & Development Corp., one of the largest copper producers in Asia, milled 25.7 million tons of 0.52% copper ore. It produced 379,100 tons of concentrates, which contained 112,540 tons of copper, up 17% from that of 1974. The company operated the Frank, Lutopan, and Biga mines on Cebu Island, Central Philippines. Atlas announced plans to develop, at a cost of $100 million, the new Carmen open pit located between the Frank and Biga pits and an associated 35,000-ton-per-day mill by early 1977. The Carmen ore body contained reserves of 352 million tons grading 0.43% copper. These reserves were in addition to the 769 million tons of 0.47% copper contained in the two operating properties. Atlas also initiated plans to construct, pending Government approval, a new $200 million smelter, refinery, and acid plant complex by 1978. The smelter will be built to handle 525,000 tons of concentrates annually. In 1975, average concentrate grade was 29.7% copper. Capacity of the refinery was planned at 144,000 tons.

Marcopper Mining Corp., a subsidiary of Placer Development, Ltd., milled 7.2 million tons of 0.58% copper ore. The copper contained in the concentrates was 38,300 tons, off 26% from 1974. Minable reserves at yearend were 95 million tons at a 0.40% cutoff and a 0.58% average grade of copper. A $43 million expansion program to increase mill capacity from 18,000 to 27,000 tons per day was largely completed by yearend.

Marinduque Mining & Industrial Corp. operated the Sipalay open pit in Negros Oriental and the Bagacay pit in Samar. At Sipalay, despite a drop in head grade from 0.66% to 0.57%, copper production for the year totaled 26,753 tons of contained copper, about the same as in 1974. Plans to increase the Sipalay mill capacity from 20,000 to 55,000 tons per day of ore were suspended until more favorable economic conditions prevail. Production at Bagacay amounted to 7,018 tons of copper contained in 28,300 tons of concentrates and, in addition, 23,700 tons of direct-shipping-grade ore. Grade of the direct-shipping ore based on reserves was 12.72% copper. Approximately 3 years of reserves remain at Bagacay. In 1975, Marinduque, Lepanto Consolidated Mining Co., and two other Philippine mining companies formed the Copper Smelter Corp. of the Philippines (CSCP). CSCP completed process and design engineering studies for a $250 million flash smelter and refinery complex to be established in Negros Occidental with a capacity of 93,000 tons of cathode copper per year plus byproduct gold and silver. Plans for the project have been submitted to the President's Copper Smelter Advisory Committee for approval and possible Government assistance.

Philex Mining Corp. increased production 3% in 1975 to 29,880 tons of copper contained in concentrates. The company operated the Santo Tomas II underground mine near Benguet, northern Luzon, with reserves of 177 million tons of ore grading 0.45% copper and 0.031 ounce of gold per ton. Mill capacity was increased from 15,400 to 26,500 tons of ore per day by July 1975.

Lepanto Consolidated Mining Co. operated the Lepanto underground mine in Mt. Province, northern Luzon, with production of 14,670 tons of copper contained in concentrates representing only 50% of the 1968–73 average output. The mill treated 899,000 tons of ore yielding 53,800 tons of concentrates. ASARCO, which normally handles the bulk of Lepanto high arsenic-antimony concentrates, reduced smelting of Lepanto feed for the last 3 months of 1975 due to the affect of U.S. arsenic air pollution regulations on its Tacoma, Wash., smelter. With a stockpile in hand of 64,000 tons of concentrates, greater than the year's production of 48,300 tons, the decision was made to suspend Lepanto operations on December 10, 1975. Reserves at the Lepanto mine were reduced at yearend to 8.3 million tons of 2.62% copper and 0.137 ounce of gold per ton. Legal claim problems delayed engineering feasibility studies on Lepanto's Hinobaan deposit in Negros Occidental. Reported reserves at Hinobaan by yearend were increased to 155 million tons of 0.5% copper.

Western Minolco, in the first full year of operation at its Boneng and Lobo ore bodies at Benguet, northern Luzon, produced 38,075 tons of concentrates from 4.3 million tons of ore milled in 1975 containing 9,350 tons of copper. An expansion program was started to increase the initial mill capacity of 16,500 tons of ore per day to 33,000 tons of ore per day, equivalent to about 50,000 tons of contained copper annually by 1976. Combined ore reserves at Boneng-Lobo were estimated at 108 million tons of 0.48% copper.

Poland.—In 1975, ore mined totaled 18.7 million tons yielding 297,600 tons of copper, an increase of 36% over 1974. Copper mine production came mainly from three underground mines, Lubin, Polkowice, and Rudna, all located in the sedimentary Kupferschiefer beds of the Legnica-Glogow copper region. A new smelter was planned for this region as copper production was planned to increase 20% annually. Poland's copper development program was based on reserves which increased fourteenfold since 1954, and including one deposit being exploited in the Lubin area, described as one of the world's largest copper deposits.

Rhodesia, Southern.—M.T.D. (Mangula) Ltd., a Messina Transvaal subsidiary, during the year ending September 30, 1975, produced 14,900 tons of copper in concentrates and precipitates from the Mangula mine about 80 miles northwest of Salisbury. Concentrates containing 14,900 tons of copper were produced from milling 1.4 million tons of sulfide ore. Precipitates containing 2,200 tons of copper were produced from treating 377,000 tons of an oxidized ore in the leach plant. Leach plant operations were closed at yearend due to the exhaustion of oxide reserves. Proven sulfide ore reserves were 16.5 million tons averaging 1.24% copper. The Norah and Silverside mines produced an additional 3,040 tons and 1,820 tons, respectively, of copper in concentrates. Proven ore reserves were 3.26 million tons of 1.21% copper at the Norah mine and 515,000 tons of 1.67% copper at the Silverside mine.

Lomagundi Smelting and Mining Ltd., also a Messina Transvaal subsidiary, produced 1,930 tons of copper in concentrate from mining and milling 282,200 tons of 0.95% copper ore from the Alaska mine. The Shackleton mine yielded 11,440 tons of copper in concentrate from 691,000 tons of 1.75% copper ore. Proved reserves at yearend were 500,000 tons of 1.18% copper at the Alaska mine and 1.7 million tons of 1.94% copper at the Shackleton mine. The Gwai River mine produced 536 tons of copper in concentrate from mining and milling 75,000 tons of 0.78% copper ore. The mine was placed on a care and maintenance basis in March 1975. Only 207,000 tons of 1.00% proven copper reserves remained.

South Africa, Republic of.—O'okiep Copper Co., Ltd., a subsidiary of Newmont Mining Corp., mined and milled 2.6 million tons of ore with an average grade of 1.38% copper, which yielded 33,800 tons of blister copper compared with 35,800 tons in 1974. Ore reserves at O'okiep mines at the end of 1975 were estimated at 29.5 million tons averaging 1.62% copper. Adverse market conditions forced the shutdown of two mines and one of three mills by the company. O'okiep and the Tsumeb Corp. Ltd. (South-West Africa) continued to defer construction of a new 130,000-ton-per-year electrolytic copper refinery in the Capetown area to refine the smelter output of the two companies.

Palabora Mining Co. Ltd., assisted by good demand for copper in South Africa, produced 101,200 tons of copper, a 1% increase over that of 1974. The ore milled, 21 million tons of 0.56% copper, was equal to the 1974 level. A major, $100 million expansion of the open pit mining and ore processing facilities was underway with completion expected early in 1977. Milling capacity was to be increased from an average 58,000 tons to 82,000 tons of ore per day, equivalent to 138,000 tons of copper annually. The capacity of the electrolytic refinery will be increased to handle the entire copper output, allowing Palabora to retain its position as one of the lowest cost copper producers in the world.

Messina (Transvaal) Development Co. mined and milled 1.13 million tons of 0.94% copper ore from its Messina mine, which yielded 10,450 tons of copper in concentrate. The tonnage of proved ore reserves at yearend was estimated at 5.4 million tons averaging 1.40% copper.

South-West Africa, Territory of.—The Tsumeb Corp. Ltd. mined 467,000 tons of ore from the Tsumeb mine averaging 4.27% copper, 9.73% lead, and 2.47% zinc. At the Kombat mine 337,200 tons of ore grading 1.31% copper and 2.17% lead was milled. The Matchless mine, near Windhoek, produced 112,600 tons of higher grade ore averaging 2.72% copper. Smelter production at Tsumeb was 40,100 tons of blister compared with 51,400 tons in 1974. Approximately 35% of this total was from smelting of toll and custom concentrates. The smelter was expanded during the year to handle an additional 140,000 tons per year of toll and custom concentrates from other mines in South-West Africa. Combined ore reserves at the end of 1975 were estimated at 8.9 million tons averaging 4.24% copper, 5.76% lead, and 1.30% zinc for the Tsumeb, Kombat, and Matchless mines and the Asis Ost and West ore bodies, recently discovered adjacent to Kombat.

Oamites Mining Co. (Proprietary) Ltd. (75% Falconbridge) milled 626,100 tons of ore grading 1.31% copper. Metal recovery in 21,000 tons of concentrate was 93.40% yielding 7,553 tons of copper, an increase of 8% over 1974. The increase, offsetting the lower tonnage mined, was attributed to improved grade and mining control and higher metallurgical recovery.

Spain.—Rio Tinto Patiño S.A. (RTP), operated the Cerro Colorado open pit mines and a custom smelter-refinery complex in the southern province of Huelva in 1975 and the Santiago open pit mine in northwest Spain, which started up in June 1975. The Santiago mine, with an annual design capacity of 7,900 tons, in its first 6 months of operation, treated 787,000 tons of ore yielding 4,850 tons of copper. At Cerro Colorado, despite a 7% increase in ore treated to 3.26 million tons, total copper production decreased 10% to 21,600 tons. Ore reserves remaining include 70 million tons of 0.64% copper at Cerro Colorado and 20 million tons of 0.68% copper at Santiago. A major expansion program was completed during the year at Huelva with the opening of a new flash smelter and a second acid plant in September, increasing anode copper capacity to 93,000 tons annually.

The RTP smelter produced 61,000 tons of anode copper from primary feed and 57,900 tons from secondary sources. The expanded electrolytic refinery, with a capacity of 116,000 tons, produced 88,600 tons of refined copper compared with 80,800 tons in 1974.

Andaluzia de Piritas, S.A., began initial production from the Aznacolla mine in southern Spain in mid-1975. The $170 million mine-mill development will have a capacity of 14,000 tons of contained copper annually. Reserves in the complex pyritic and cupriferous shale ore deposit were estimated at 86 million tons of about 0.44% copper.

Sweden.—Boliden Aktiebolag, which produces essentially all of Sweden's blister and refined copper, announced plans to expand the capacity of the Ronnskar smelter-refinery complex to 94,000 tons per year by 1978 and to 110,000 tons per year at a later date, at a total estimated cost of $200 million.

U.S.S.R.—In 1975, the Soviet Union produced an estimated 1,019,000 tons of copper, including 843,000 tons of primary and 176,000 tons of secondary copper. An estimated 227,000 tons of this output was exported in 1975. The Kazakstan copper industrial region continued to be the main center of copper production having increased refined metal production 50% during the 1971–75 period with an additional 25% increase called for under the 1976–80 5-year plan. While a shortage of ore was experienced at the Balkhash and Dzhezhazgan complexes within Kazakstan, the small Sayak-III porphyry copper open pit mine at Balkhash was completed, and development work at the No. 65 mine, within the large, sedimentary 1.6% to 1.9% copper-sandstone deposits of Dzhezhazgan, was begun during the year. Scheduled for completion by 1980 in Kazakstan are the new Akchu-Spassk, Dzheladinsk, Kargalinsk, Orlovsk, and the polymetallic Irtysh mines, and the expansion of the Tishinenk and Annensk mines.

In the Urals, the second largest copper-producing region, a prolonged lag in exploration and mine development created an imbalance between mine and smelter production. The Urals mines can supply only two-thirds of the concentrate feed for the Krasnouralsk, Kirovograd, and Karabash smelters, with the remaining feed requirements transported in at higher costs. Mine expansion and development programs were near completion or underway at Gaysk, Orenburg Oblast, and Bashkir.

In Uzbekstan, development of the Sarycheku copper mine, in the Almalyk porphyry copper mine and flash smelter complex, was completed in 1975. At the Norilsk copper-nickel complex in Siberia, three Finnish firms were constructing an Outokumpu-design flash smelter capable of treating 600,000 tons of copper concentrate annually. The Soviet Government is currently soliciting bids from western firms for a 110-ton-per-day pilot plant to test the Udokan sedimentary copper deposit in eastern Siberia. The deposit was reportedly one of the largest copper reserves in the world with reserves estimated at over 1.3 billion tons of ore containing an average copper content of about 2%, approximately 20% in the oxide form. Rio-Tinto Zinc has submitted bids on the pilot plant and Earth Resources Co. (ERC), was negotiating with the Soviet Union on the licensing of a patented flotation developed by ERC for improving the recovery of copper from similar sedimentary oxide ores at the Nacimiento, N. Mex., mine. The Udokan deposit has the potential for producing up to 440,000 tons of refined copper per year. Development of another major mining complex was also underway on the porphyry copper-molybdenum deposit at Erdenet, Mongolia.

Yugoslavia.—Estimated primary production of copper by Rudarsko Topionicarski Bazen (RTB), Bor, Serbia, included 126,700 tons of copper in concentrates, 178,600 tons of blister copper, and 136,600 tons of refined copper. RTB operated a mine, flotation plant, and smelter at Bor, and a mine and flotation plant at Majdanpek. Expansion of the Majdanpek mill to handle 12 million tons of ore annually was completed during the year. Development work continued on the large 660-million ton, 0.5% copper deposit at Krivelj with plans for an annual capacity of 66,000 tons of copper, to be reached by 1981. Work also continued on the development of the second major copper-producing facility in Yugoslavia at Bucim, near Radoviste, Macedonia. Work on a mine and beneficiation plant at the Bucim copper deposit continued during the year and was scheduled to reach an annual capacity of 23,000 tons of copper in concentrates by 1977.

Zaire.—Mining the highest grade copper ore in the world with an average reserve content in producing mines of 3.83% copper, Zaire produced 547,100 tons of copper, less than 1% below that of 1974. Disruptions caused by the closure of the Benguela railroad from Shaba Province to the Angolan port of Lobito, as a result of the Angolan Civil War, had a strong impact on the economy and copper industry of Zaire in the latter part of 1975. According to CIPEC statistics, Zaire was able to export only 68% of 1975 copper production. With the loss of the Benguela railroad, which normally handles 38% of Shaba's imports and 61% of its exports, primarily mineral, alternative overland trade routes were established. Zairian copper was redirected through Zambia to the Mozambique port of Beira and via the newly opened Tanzania-Zambia Railway (Tazara), to the port of Dar es Salaam.

The Government mining agency, La Générale des Carrières et Mines du Zaire (Gécamines), which operated 10 mines, 5 mills, 1 copper smelter at Lubumbashi, and 2 copper-cobalt refineries at Shituru and Luilu in Shaba Province, produced 510,860 tons of copper including 160,750 tons of blister and 335,650 tons of copper refined shapes. Plans to increase annual production of copper to 628,000 tons by 1978 were still on schedule. Plans called for the construction of a 138,000-ton-per-year flash smelter and a 100,000-ton-per-year electrolytic copper refinery, all near Kolwezi, Shaba. As part of the expansion program, two new, open pit mines at Dikuluwe and Mashambe, with combined reserves estimated at 171 million tons of 4.1% copper and 0.3% cobalt, opened in late 1975 but operated at a low rate due to diesel fuel shortages. The Gécamines refinery at Lubumbashi was also scheduled to be expanded from 143,000 tons per year to 176,000 tons per year by 1980.

The joint Zairian Government-Japanese company Société de Dévelopement Industriel et Minière du Zaire (SODIMIZA), operated the Mushoshi mine and mill in Shaba Province increasing mine production 12% to 1.68 million tons of ore in 1975. Production of 103,950 tons of concentrate with an average copper content of 34.4% yielded 35,760 tons of contained copper. SODIMIZA continued development of the Kinsenda mine during the year but production is not expected to begin before 1978.

Société Minière de Tenke Fungurume (SMTF), controlled by the Republic of Zaire (20%) and a consortium comprised of Charter Consolidated Ltd. and Associated Companies (28%), AMOCO Minerals Co. (28%), Mitsui and Co. Ltd. (14%), Bureau de Recherches Geologiques & Miniéres (3.5%), Omnium des Mines, S.A. (3.5%), and Leon Templesman & Son Inc. (3%), made substantial progress on the construction and development of the Tenke-Fungurume project up until August 1975. At that time regional fuel shortages and serious financial support problems threatened the continuation of the project. By yearend, consideration was being given to suspending work on the 165,000-ton-per-year mine-electrowinning refinery complex originally scheduled for completion in 1977 with cost estimates that increased from $600 million to $900 million.

Zambia.—The Government assumed full operational control over the Zambian copper industry during the year as the management and sales contracts with both AMAX Inc., and the Anglo-American Corp. of South Africa Ltd. were terminated. AMAX is to receive compensation of $34 million owing to the contract termination. A new Metal Marketing Corp. of Zambia, Ltd. (Memaco), has been set up to handle all copper sales on behalf of the Government. Low prices and export transportation problems precipitated by the Angolan Civil War left the industry in serious financial difficulties. The closure of the Benguela railroad to the port of Lobito, Angola, in August caused the declaration of "force majeur" on 20% of copper deliveries from early September with Roan Consolidated Mines Ltd. (RCM) increasing it to 30% and Nchanga Consolidated Copper Mines Ltd. (NCCM) to 40% in October. The new Tazara railroad began operations on a limited basis in September with shipments of copper to the port of Dar es Salaam. Mine production in 1975 decreased 3% to 746,200 tons of recoverable copper, and blister and refined copper output decreased 7% to 693,500 tons.

RCM mined 17.5 million tons of ore with an average grade of 2.01% yielding 318,100 tons of copper during the year from the Mufulira, Luanshya, Chambishi, Chibuluma, and Kalengwa mines. RCM also operated two smelters at Mufulira and Luanshya that produced 311,650 tons of anode copper. The Mufulira and Ndola Copper refineries produced 344,600 tons of copper cathodes, 304,200 tons of which was cast into wirebars. The electrowinning plant at Chambishi produced 16,270 tons of leach cathodes. Poor ground conditions continued to cause difficulties at Mufulira and Luanshya; production was suspended for 4½ months at Chambishi to concentrate on overburden stripping. Work continued on a $200 million development program to expand mine production at the Baluba section of Luanshya, Chibuluma, and Chambishi; to extend the Chambishi leach plant; and to build an anode slimes treatment plant at Ndola. Development of the Kalushi East mine has been deferred. Ore reserves at all RCM mines are estimated to total 375 million tons of ore with an average grade of 2.96% copper. The Mufulira and Luanshya mines contain 79% of this reserve total.

NCCM for the year ended March 31, 1975, produced 450,473 tons of finished copper from operations at its Rokana, Konkola, and Chingola mine divisions, its smelter-refinery complex at Kitwe, and from the refinery at Chingola. At the Rokana division, mine output increased 8% to 157,500 tons of copper. The 14,000-ton-capacity Mindola open pit and oxide treatment plant were placed on a care and maintenance basis at the end of 1975 while expansion of the Mindola underground operations continued. At the Konkola division, mine production decreased 5% to 57,870 tons. Production of copper at the Chingola division decreased 4% to 366,180 tons, 60% of this from five open pit operations. A major low-grade tailings leach plant completed its first year of operation in April 1975 with low copper recovery rates still a problem. NCCM controls 578 million tons of ore reserves averaging 3.20% copper with 43% of these held within the Chingola division.

TECHNOLOGY

A study of porphyry copper occurrences in the Southwestern Pacific Island arc areas showed that, compared with Western Hemisphere porphyries, the deposits are geologically younger and have less discrete zones of alteration.[2] A similar study of copper porphyry occurrences in the Northern Caribbean region compared the associated intrusive rocks with those of the Southwest Pacific and continental porphyry deposits.[3] The generally assumed inverse tonnage-grade relationships for porphyry copper deposits have been challenged and, if true, have important implications for total resource estimates and future mining grades.[4]

A microscopic study on samples from a drill core yielded a detailed analysis of the mineralogy and paragenesis of a portion of the copper-nickel deposition in northern Minnesota.[5] Geologic descriptions of a porphyry copper deposit and several massive sulfide copper deposits were published.[6]

The technology and economic evaluation of processing ocean nodules, using hydrometallurgical techniques, was published.[7] Another article described the use of a pyrometallurgical method as an alternative approach for processing the nodules.[8] Use of petrography as an important tool to evaluate processing options for copper ores was described in an article on the subject.[9]

A pilot-scale test on injection of oxygen into a near dormant leach resulted in a significant reactivation of the leaching with the improvement attribute to stimulation of bacterial action, better oxidation, and increased permeability.[10] Experiments on crushing and sizing of copper-containing mine strip waste with the fines treated by flotation and the coarse treated by leaching resulted in a 71% copper recovery, compared with a 48% recovery by leaching the unsized material.[11] Field tests on fragmenting a copper deposit for potential in situ leaching showed suitable fragmentation for the tests of 15-, 20-, and 25-foot spacings to a depth of 110 feet.[12]

Cyprus Mines Corp. reported promising results from demonstration plant tests in the continuing development of its Cymet hydrometallurgical process for treating copper sulfide concentrate. New procedures

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[2] Titley, S. R. Geological Characteristics and Environment of Some Porphyry Copper Occurrences in the Southwestern Pacific. Econ. Geol., v. 70, No. 3, May 1975, pp. 499–514.

[3] Kesler, S. E., L. M. Jones, and R. L. Walker. Intrusive Rocks Associated With Porphyry Copper Mineralization in Island Arc Areas. Econ. Geol., v. 70, No. 3, May 1975, pp. 515–526.

[4] Whitney, J. W. A Resource Analysis Based on Porphyry Copper Deposits and the Cumulative Copper Metal Curve Using Monte Carlo Simulation. Econ. Geol., v. 70, No. 3, May 1975, pp. 527–537.

[5] Boucher, M. L. Copper-Nickel Mineralization in a Drill Core From the Duluth Complex of Northern Minnesota. BuMines RI 8084, 1975, 55 pp.

[6] Franklin, J. M., J. Kasarda, and K. H. Poulsen. Petrology and Chemistry of the Alteration Zone of the Mattabi Massive Sulfide Deposit. Econ. Geol., v. 70, No. 1, January–February 1975, pp. 63–79.

Spence, C. D. Volcanogenic Features of the Vauze Sulfide Deposit, Noranda, Quebec. Econ. Geol., v. 70, No. 1, January–February 1975, pp. 102–114.

Spence, C. D., and A. F. DeRosen-Spence. The Place of Sulfide Mineralization in the Volcanic Sequence at Noranda, Quebec. Econ. Geol., v. 70, No. 1, January–February 1975, pp. 90–101.

Waterman, G. C., and R. L. Hamilton. The Sar Cheshmeh Porphyry Copper Deposit. Econ. Geol., v. 70, No. 3, May 1975, pp. 568–576.

[7] Agarwal, J. C., N. Beecher, D. S. Davies, G. L. Hubred, V. K. Kakaria, and R. N. Kust. Processing of Ocean Nodules: A Technical and Economic Review. J. Metals, v. 28, No. 4, April 1976, pp. 24–31.

[8] Sridhar, R., W. E. Jones, and J. S. Warner. Extraction of Copper, Nickel and Cobalt From Sea Nodules J. Metals, v. 28, No. 4, April 1976, pp. 32–37.

[9] Agarwal, J. C., N. Schapiro, and W. J. Mallio. Process Petrography and Ore Deposits. Min. Cong. J., v. 62, No. 3, March 1976, pp. 28–35.

[10] Madsen, B. W., and R. D. Groves. Using Oxygen To Reactivate a Nearly Dormant Copper Sulfide Leach. BuMines RI 8056, 1975, 9 pp.

[11] Madsen, B. W., R. D. Groves, L. G. Evans, and G. M. Potter. Prompt Copper Recovery From Mine Strip Waste. BuMines RI 8012, 1975, 19 pp.

[12] Steckley, R. C., W. C. Larson, and D. V. D'Andrea. Blasting Tests in a Porphyry Copper Deposit in Preparation for In Situ Extraction. BuMines RI 8070, 1975, 47 pp.

eliminated the electrorefining circuit and yielded a high-purity copper with a reduction from a high power consumption of 3.5 to less than 1 kilowatt-hour per pound of copper produced. Preliminary engineering and economic studies indicated that the process may result in a significant saving in capital and operating costs compared with conventional pyrometallurgical processes.[13]

Several review articles[14] evaluated developments in hydrometallurgy with respect to the relative economics of copper production and efficiencies of environmental controls. Another article presented information on the application of stainless steel as containment vessels and other equipment in hydrometallurgy.[15]

Research has shown that sulfur in copper concentrate can be converted into insoluble anhydrite by roasting the concentrate with lime. After leaching the calcine to recover the metal values, the residues may be discarded without harm to the environment.[16] Laboratory tests on copper concentrate utilizing a combined nitrogen roast—two stage leach—electrowinning approach show promise as a process for recovering copper, sulfur, iron oxide, and valuable minor metals with a minimum impact on the environment.[17] Recent research has improved on procedures to recover copper and iron from a leach solution and to recover sulfur from the residue resulting from a ferric chloride leach of chalcopyrite concentrate.[18] Chlorination rates of sulfide minerals for application to hydrometallurgy processes were determined and analyzed.[19] Research on the application of solvent extraction to alkaline leach solutions was published.[20] An article described the initial phase of a study to recover copper and elemental sulfur from copper concentrate by using a sulfur dioxide pressure leaching process.[21]

An article reviewed the history of reverberatory-converter smelting and the emerging new smelting processes in response to tightening energy supplies and stringent environmental controls.[22] Investigations by the Smelter Control Research Association to control sulfur dioxide emissions were described in an article with particular emphasis on the promising ammonia double-alkali process.[23] Bench-scale tests were conducted to demonstrate the use of hydrogen for a direct-reduction process of recovering copper from copper concentrate.[24]

A paper reviewed the theory of the electrocrystallization of copper and extrapolated the fundamental conclusions to practical problems in the electrodeposition of copper.[25] Other research determined parameters of resistance and current distributions in copper refinery tankhouses.[26] An article reviewed the economic and technical advantages causing a greater application of the use of titanium cathodes in the starter sheet sections of copper refineries.[27]

Results of a study to identify and assess the relative importance of factors affecting

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[13] Cyprus Mines Corporation. 1975 Annual Report. Pp. 35–37.

[14] Jansen, M. L., and D. A. Milligan. Developments in Sulfur Disposal Techniques in Hydrometallurgy. J. Metals, v. 27, No. 1, January 1975, pp. 13–17, 23.

Rosenzweig, M. D. Copper Makers Look to Sulfide Hydrometallurgy. Chem. Eng., v. 83, No. 1, January 1976, pp. 79–81.

[15] Kopecki, E. S. Stainless Steel: Effective Corrosion Control for Copper Recovery Operations. Eng. and Min. J., v. 176, No. 5, May 1975, pp. 117–121.

[16] Haver, F. P., and M. M. Wong. Lime Roast-Leach Method for Treating Chalcopyrite Concentrate. BuMines RI 8006, 1975, 17 pp.

[17] Gabler, R. C., Jr., B. W. Dunning, Jr., R. E. Brown, and W. J. Campbell. Processing Chalcopyrite Concentrates by a Nitrogen Roast-Hydrometallurgical Technique. BuMines RI 8067, 1975, 18 pp.

[18] Haver, F. P., R. D. Baker, and M. W. Wong. Improvements in Ferric Chloride Leaching of Chalcopyrite Concentrate. BuMines RI 8007, 1975, 16 pp.

[19] Landsberg, A., A. Adams, and J. L. Schaller. Chlorination Kinetics of Selected Metal Sulfides. BuMines RI 8002, 1975, 15 pp.

[20] Ritcey, G. M., and B. H. Lucas. Extraction and Separation of Copper, Nickel, Zinc and Cobalt From Ammoniacal Solution Using Kelex® 100. Can. Min. and Met. Bull., v. 68, No. 754, February 1975, pp. 105–113.

[21] Meyers, R. A., J. W. Hamersman, and M. L. Kraft. Sulfur Dioxide Pressure Leaching, New Pollution-Free Methods To Process Copper Ore. Environmental Sci. & Technol., v. 9, No. 1, January 1975, pp. 70–71.

[22] Themelis, N. J. The Impact of Energy and Environmental Constraints on Copper Smelting Technology. Min. Eng., v. 28, No. 1, January 1976, pp. 42–46.

[23] Campbell, I. E. Developments in Sulfur Dioxide Control. Min. Cong. J., v. 61, No. 11, November 1975, pp. 56–59.

[24] Habashi, F. Direct Reduction—A Possible Route to Copper. Min. Mag., v. 133, No. 3, September 1975, pp. 171, 173.

[25] Winand, R. Electrocrystallization of Copper. Inst. Min. and Met. Trans., v. 84, No. 823, June 1975, pp. C67–C75.

[26] Harvey, W. W., M. R. Randlett, and K. I. Bangerskis. High Current Density Copper Electrorefining and Electrowinning in a Series Cell, Part 1—Electrorefining. J. Metals, v. 27, No. 7, July 1975, pp. 19–25.

Mackey, P. J., P. Tarassoff, and G. Lemelin. Current Distribution and Resistances in Copper Refinery Tankhouse Cells. Inst. Min. and Met. Trans., v. 84, No 820, March 1975, C42–C48.

[27] Engineering and Mining Journal. Copper Refineries Expanding Use of Ti Cathodes. V. 176, No. 4, April 1975, p. 101.

the supply and demand of secondary copper were made available.[28]

New treatment techniques to remove copper from waste water streams, such as in metal-plating operations, have been reported.[29]

[28] Bonczar, E. S., and J. E. Tilton. An Economic Analysis of the Determinants of Metal Recycling in the United States: A Case Study of Secondary Copper (Research Grant G0133114). BuMines Open File Rept. 79–75, 1975, 88 pp; available for consultation at the Bureau of Mines libraries in Juneau, Alaska, Denver, Colo., Pittsburgh, Pa., Spokane, Wash., and at the Central Library, U.S. Department of the Interior, Washington D.C.; and from National Technical Information Service, U.S. Department of Commerce, Springfield, Va., PB 245 832/AS.

[29] Ricci, L. J. Heavy-Metals Recovery Promises To Pare Water-Cleanup Bills. Chem. Eng., v. 82, No. 27, December 1975, pp. 29–31.

Table 2.—Copper produced from domestic ores, by source

(Thousand short tons)

Year	Mine	Smelter	Refinery
1971	1,522	1,471	1,411
1972	1,665	1,649	1,680
1973	1,718	1,705	1,698
1974	1,597	1,532	1,421
1975	1,413	1,374	1,286

Table 3.—Copper ore and recoverable copper produced, by mining method

(Percent)

Year	Open pit		Underground	
	Ore	Copper [1]	Ore	Copper [2]
1971	88	82	12	18
1972	85	80	15	20
1973	89	78	11	22
1974	89	81	11	19
1975	89	80	11	20

[1] Includes copper from dump leaching.
[2] Includes copper from in-place leaching.

Table 4.—Mine production of recoverable copper in the United States, by month

(Short tons)

Month	1974	1975
January	135,170	131,272
February	131,063	117,793
March	144,461	117,595
April	143,290	123,219
May	150,399	126,890
June	142,163	111,476
July	99,435	95,488
August	102,124	114,510
September	132,438	118,701
October	145,366	128,568
November	135,934	111,658
December	135,159	116,196
Total	1,597,002	1,413,366

Table 5.—Mine production of recoverable copper in the United States, by State
(Short tons)

State	1971	1972	1973	1974	1975
Arizona	820,171	908,612	927,271	858,783	813,211
California	515	598	369	194	344
Colorado	3,938	3,944	3,123	3,012	3,560
Idaho	3,776	2,942	3,625	2,841	3,192
Maine	2,510	1,220	1,107	1,522	2,024
Michigan	56,005	67,260	72,221	67,012	73,690
Missouri	8,445	11,509	10,273	12,665	14,258
Montana	88,581	123,110	132,466	131,131	87,959
Nevada	96,928	101,119	93,702	84,101	81,210
New Mexico	157,419	168,034	204,742	196,585	146,263
Pennsylvania	3,349	2,611	1,845		
Tennessee	13,916	11,310	8,500	6,304	10,041
Utah	263,451	259,507	256,589	230,593	177,155
Other States [1]	3,179	3,064	2,107	2,259	459
Total	1,522,183	1,664,840	1,717,940	1,597,002	1,413,366

[1] Includes Oklahoma, Oregon, Washington, and Wisconsin (1975).

Table 6.—Twenty-five leading copper-producing mines in the United States in 1975, in order of output

Rank	Mine	County and State	Operator	Source of copper
1	Utah Copper	Salt Lake, Utah	Kennecott Copper Corp	Copper ore, copper precipitates.
2	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper ore, copper precipitates, copper tailings.
3	San Manuel	Pinal, Ariz	Magma Copper Co	Copper ore.
4	Sierrita	Pima, Ariz	Duval Sierrita Corp	Do.
5	Tyrone	Grant, N. Mex	Phelps Dodge Corp	Copper ore, copper precipitates.
6	Pima	Pima, Ariz	Cyprus Pima Mining Co	Copper ore.
7	White Pine	Ontonagon, Mich	White Pine Copper Co	Do.
8	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Copper ore, copper precipitates.
9	Ray Pit	Pinal, Ariz	Kennecott Copper Corp	Do.
10	Pinto Valley	Gila, Ariz	Cities Service Co	Do.
11	Chino	Grant, N. Mex	Kennecott Copper Corp	Do.
12	Inspiration	Gila, Ariz	Inspiration Consolidated Copper Co.	Do.
13	Magma	Pinal, Ariz	Magma Copper Co	Copper ore.
14	Yerington	Lyon, Nev	The Anaconda Company	Copper ore, copper precipitates.
15	Metcalf	Greenlee, Ariz	Phelps Dodge Corp	Do.
16	New Cornelia	Pima, Ariz	do	Copper ore, gold ore.
17	Ruth Pit	White Pine, Nev	Kennecott Copper Corp	Copper ore.
18	Mission	Pima, Ariz	ASARCO Incorporated	Do.
19	Sacaton Unit	Pinal, Ariz	do	Do.
20	Bagdad	Yavapai, Ariz	Cyprus Bagdad Copper Co	Do.
21	Silver Bell	Pima, Ariz	ASARCO Incorporated	Copper ore, copper precipitates.
22	Continental	Grant, N. Mex	UV Industries, Inc	Do.
23	Mineral Park	Mohave, Ariz	Duval Corp	Do.
24	Twin Buttes	Pima, Ariz	Anamax Mining Co	Copper ore.
25	Esperanza	do	Duval Corp	Copper ore, copper precipitates.

Table 7.—Mine production of recoverable copper in 1975, by method of treatment

Method of treatment	Ore treated (thousand short tons)	Recoverable copper: Thousand pounds	Recoverable copper: Percent yield	Remarks
Copper ore:				
By concentration	239,614	2,295,390	0.48	See table 9.
By smelting	357	13,202	1.85	See table 10.
By leaching	23,032	[1] 174,932	.38	See table 11.
Total	263,003	2,483,524	.47	
Dump and in-place leaching	--	288,587	--	See table 11.
Miscellaneous from cleanup, tailings, and noncopper ores	--	54,622	--	
Total	XX	2,826,733	XX	

XX Not applicable.
[1] Includes 74,529,804 pounds of electrowon copper.

Table 8.—Copper ore shipped directly to smelters or concentrated in the United States, by State in 1975, with copper, gold, and silver content in terms of recoverable metal

State	Ore shipped or concentrated (thousand short tons)	Copper: Thousand pounds	Copper: Percent	Gold (troy ounces)	Silver (troy ounces)	Value of gold and silver per ton of ore
Arizona	151,427	1,360,839	0.45	82,385	6,155,669	$0.27
Colorado	4	81	1.01	223	37,851	55.10
Idaho	123	1,294	.53	36	37,377	1.39
Michigan	9,033	147,380	.82	--	632,336	.31
Montana	19,262	140,057	.36	13,317	2,151,969	.61
Nevada	11,674	117,102	.50	33,288	701,940	.73
New Mexico	19,401	241,481	.62	12,634	660,505	.26
Tennessee [1]	1,635	20,083	.61	W	52,197	.15
Utah	27,380	279,381	.51	W	W	W
Other States	33	894	1.31	[2] 183,737	[2] 1,702,801	[2] 1.36
Total [3]	239,971	2,308,592	.48	325,620	12,132,645	.44

W Withheld to avoid disclosing individual company confidential data; included in "Other States."
[1] Copper-zinc ore.
[2] Includes data for Utah.
[3] Data may not add to totals shown because of independent rounding.

Table 9.—Copper ore concentrated [1] in the United States, by State in 1975, with content in terms of recoverable copper

State	Ore concentrated (thousand short tons)	Recoverable copper content: Thousand pounds	Recoverable copper content: Percent
Arizona	151,168	1,348,042	0.89
Colorado	2	29	.69
Idaho	123	1,294	.53
Michigan	9,033	147,380	.82
Montana	19,261	140,047	.36
Nevada	11,674	117,102	.50
New Mexico	19,366	241,437	.62
Tennessee [2]	1,635	20,083	.61
Utah	27,319	279,095	.51
Other States	33	881	1.33
Total	239,614	2,295,390	.48

[1] Includes following methods of concentration: "Dual process" (leaching followed by concentration); "LPF" (leach-precipitation-flotation); and froth flotation.
[2] Copper-zinc ore.

Table 10.—Copper ore shipped directly to smelters[1] in the United States, by State in 1975, with content in terms of recoverable copper

State	Ore shipped to smelters		
	Short tons	Recoverable copper content	
		Pounds	Percent
Arizona	258,877	12,796,668	2.47
Colorado	1,598	52,349	1.64
Montana	524	10,195	.97
New Mexico	35,209	43,755	.06
Utah	60,556	286,613	.24
Other States	339	12,181	1.80
Total	357,103	13,201,761	1.85

[1] Primarily smelter fluxing material.

Table 11.—Copper precipitates (from dump or in-place leaching) shipped directly to smelters and copper ore and tailings leached (heap, vat, or tank) in the United States, by State in 1975, with content in terms of recoverable copper

State	Precipitates shipped (short tons)	Recoverable copper content (pounds)	Ore leached (short tons)	Recoverable copper content (pounds)	Percent
Arizona	85,170	111,696,353	[1]17,229,313	[2]147,000,303	0.43
California	1	595	--	--	--
Montana	24,211	35,799,798	--	--	--
Nevada	12,412	16,715,334	5,802,219	27,931,898	.24
New Mexico	32,957	50,028,236	--	--	--
Utah	45,997	74,347,077	--	--	--
Total	200,748	288,587,393	23,031,532	174,932,201	.38

[1] Includes 9,934,979 short tons of ore leached for electrowinning, and excludes newly generated tailings.
[2] Includes 74,529,804 pounds of electrowon copper.

Table 12.—Copper ore smelted and copper ore concentrated in the United States, and average yield in copper, gold, and silver

Year	Smelting ore		Concentrating ore		Total				
	Thousand short tons	Yield in copper (percent)	Thousand short tons [1] [2]	Yield in copper (percent)	Thousand short tons [1]	Yield in copper (percent)	Yield per ton in gold (ounce)	Yield per ton in silver (ounce)	Value per ton in gold and silver
1971	453	1.76	222,121	0.56	242,656	0.55	0.0022	0.059	$0.18
1972	484	1.68	248,663	.55	266,831	.55	.0019	.059	.21
1973	337	1.40	272,688	.53	289,998	.53	.0018	.058	.32
1974	305	1.26	269,016	.50	293,443	.49	.0014	.048	.45
1975	357	1.85	239,614	.48	263,003	.47	.0014	.051	.44

[1] Includes some ore classed as copper-zinc and minor amount of tailings (1971 excludes tailings).
[2] Excludes tank or vat and heap leaching. (See tables 7 and 11.)

Table 13.—Copper produced by primary smelters in the United States
(Short tons)

Year	Domestic	Foreign	Secondary	Total
1971	1,470,815	29,181	66,333	1,566,329
1972	1,649,130	41,263	69,017	1,759,410
1973	1,705,065	38,898	77,815	1,821,778
1974	1,532,066	37,750	79,543	1,649,359
1975	1,374,324	72,804	49,357	1,496,485

Table 14.—Primary and secondary copper produced by primary refineries in the United States

(Short tons)

	1971	1972	1973	1974	1975
PRIMARY					
From domestic ores, etc.:[1]					
Electrolytic	1,274,084	1,520,943	1,536,819	1,298,712	1,171,726
Lake	57,218	70,025	78,179	66,624	70,549
Casting	79,221	89,444	83,339	55,569	43,914
Total	1,410,523	1,680,412	1,698,337	1,420,905	1,286,189
From foreign ores, etc.:[1]					
Electrolytic	167,213	160,781	159,786	202,127	154,558
Casting and best select	14,046	32,040	10,365	31,626	2,631
Total refinery production of primary copper	1,591,782	1,873,233	1,868,488	1,654,658	1,443,378
SECONDARY					
Electrolytic[2]	323,913	341,581	377,523	398,976	265,413
Casting	18,599	16,667	14,290	13,543	5,467
Total secondary	342,512	358,248	391,813	412,519	270,880
Grand total	1,934,294	2,231,481	2,260,301	2,067,177	1,714,258

[1] The separation of refined copper into metal of domestic and foreign origin is only approximate, as accurate separation is not possible at this stage of processing.

[2] Includes copper reported from foreign scrap.

Table 15.—Copper cast in forms at primary refineries in the United States

	1974		1975	
	Thousand short tons	Percent	Thousand short tons	Percent
Billets	101	5	61	3
Cakes	132	6	67	4
Cathodes	661	32	765	45
Ingots and ingot bars	172	8	132	8
Wire bars	988	48	676	39
Other forms	13	1	13	1
Total	2,067	100	1,714	100

Table 16.—Production, shipments, and stocks of copper sulfate

(Short tons)

Year	Production		Shipments	Stocks Dec. 31[1]
	Quantity	Copper content		
1971	34,648	8,662	36,852	5,936
1972	38,052	9,513	37,964	5,828
1973	43,360	10,840	44,092	4,580
1974	42,092	10,523	43,598	3,074
1975	35,614	9,204	31,822	6,866

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

Table 17.—Byproduct sulfuric acid[1] (100% basis) produced in the United States
(Short tons)

Year	Copper plants[2]	Lead plants	Zinc plants[3]	Total
1971	803,284	971,946		1,775,230
1972	1,010,614	859,103		1,869,717
1973	1,088,322	146,591	819,537	2,054,450
1974	1,277,440	132,594	830,969	2,241,003
1975	1,784,744	129,756	711,769	2,626,269

[1] Includes acid from foreign materials.
[2] Excludes acid made from pyrites concentrates.
[3] Excludes acid made from native sulfur.

Table 18.—Secondary copper produced in the United States
(Short tons)

	1971	1972	1973	1974	1975
Copper recovered as unalloyed copper	429,095	447,409	484,623	513,308	355,512
Copper recovered in alloys[1]	771,025	853,564	892,534	831,012	616,453
Total secondary copper	1,200,120	1,300,973	1,377,157	1,344,320	971,965
Source:					
New scrap	754,963	842,779	890,943	860,888	602,792
Old scrap	445,157	458,194	486,214	483,432	369,173
Percentage equivalent of domestic mine output	79	78	80	84	69

[1] Includes copper in chemicals, as follows: 1971—3,206; 1972—3,038; 1973—3,704; 1974—2,649; and 1975—2,480.

Table 19.—Copper recovered from scrap processed in the United States by kind of scrap and form of recovery
(Short tons)

Kind of scrap	1974	1975	Form of recovery	1974	1975
New scrap:			As unalloyed copper:		
Copper-base	846,917	585,426	At primary plants	412,519	270,880
Aluminum-base	13,433	17,103	At other plants	100,789	84,632
Nickel-base	524	248	Total	513,308	355,512
Zinc-base	14	15			
Total	860,888	602,792	In brass and bronze	787,118	571,991
			In alloy iron and steel	2,601	1,927
Old scrap:			In aluminum alloys	38,293	39,583
Copper-base	476,331	358,496	In other alloys	351	472
Aluminum-base	6,387	10,226	In chemical compounds	2,649	2,480
Nickel-base	642	349	Total	831,012	616,453
Tin-base	8	7			
Zinc-base	64	95	Grand total	1,344,320	971,965
Total	483,432	369,173			
Grand total	1,344,320	971,965			

Table 20.—Copper recovered as refined copper, in alloys and in other forms from copper-base scrap processed in the United States
(Short tons)

Recovered by—	From new scrap		From old scrap		Total	
	1974	1975	1974	1975	1974	1975
Secondary smelters	63,904	53,606	212,541	162,508	276,445	216,114
Primary copper producers	r 229,328	139,230	r 183,191	131,650	r 412,519	270,880
Brass mills	523,102	381,744	36,319	26,140	559,421	407,884
Foundries and manufacturers	20,663	11,426	44,702	37,383	65,365	48,809
Chemical plants	1,071	1,159	1,890	1,330	2,961	2,489
Total	r 838,068	587,165	r 478,643	359,011	r 1,316,711	946,176

r Revised.

Table 21.—Production of secondary copper and copper-alloy products in the United States
(Short tons)

Item produced from scrap	1974	1975
UNALLOYED COPPER PRODUCTS		
Refined copper by primary producers	412,519	270,880
Refined copper by secondary smelters	84,389	73,606
Copper powder	16,329	10,957
Copper castings	71	69
Total	513,308	355,512
ALLOYED COPPER PRODUCTS		
Brass and bronze ingots:		
Tin bronzes	40,210	33,474
Leaded red brass and semired brass	128,250	89,799
High-leaded tin bronze	33,192	23,304
Yellow brass	15,328	9,824
Manganese bronze	11,664	9,110
Aluminum bronze	8,359	6,743
Nickel silver	3,907	2,636
Silicon bronze and brass	4,445	2,584
Copper-base hardeners and master alloys	16,198	10,765
Total	261,553	188,239
Brass-mill products	702,688	510,384
Brass and bronze castings	40,162	31,759
Brass powder	812	571
Copper in chemical products	2,649	2,723
Grand total	1,521,172	1,089,188

Table 22.—Composition of secondary copper-alloy production
(Short tons)

	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
Brass and bronze production:[1]							
1974	201,911	12,541	18,137	28,227	665	72	261,553
1975	144,209	9,297	13,419	20,848	422	44	188,239
Secondary metal content of brass-mill products:							
1974	562,196	455	3,255	132,554	4,168	60	702,688
1975	408,959	341	2,305	94,652	4,083	44	510,384
Secondary metal content of brass and bronze castings:							
1974	32,835	1,088	2,634	3,536	8	61	40,162
1975	25,860	857	1,963	3,045	1	33	31,759

[1] About 93% from scrap and 7% from other than scrap.

Table 23.—Stocks and consumption of purchased copper scrap in the United States in 1975

(Short tons)

Class of consumer and type of scrap	Stocks Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks Dec. 31
SECONDARY SMELTERS						
No. 1 wire and heavy copper	2,717	24,745	2,449	22,829	25,278	2,184
No. 2 wire, mixed heavy and light copper	2,535	62,763	17,791	42,386	60,177	5,121
Composition or red brass	4,179	50,367	11,205	38,071	49,276	5,270
Railroad-car boxes	229	1,178	--	1,083	1,083	324
Yellow brass	5,193	38,577	4,818	33,850	38,668	5,102
Cartridge cases and brass	72	35	--	75	75	32
Auto radiators (unsweated)	3,565	46,169	--	45,659	45,659	4,075
Bronze	1,421	19,913	2,789	16,853	19,642	1,692
Nickel silver and cupronickel	831	2,743	329	2,456	2,785	789
Low brass	542	2,400	1,711	618	2,329	613
Aluminum bronze	94	436	225	114	339	191
Low-grade scrap and residues	14,032	55,463	45,521	10,769	56,290	13,205
Total	35,410	304,789	86,838	214,763	301,601	38,598
PRIMARY PRODUCERS						
No. 1 wire and heavy copper	2,544	100,286	47,516	50,271	97,787	5,043
No. 2 wire, mixed heavy and light copper	4,336	128,393	76,815	52,386	129,201	3,528
Refinery brass	} 20,132	2,472	2,267	962	3,229	} 9,619
Low-grade scrap and residues		132,532	47,043	95,245	142,288	
Total	27,012	363,683	173,641	198,864	372,505	18,190
BRASS MILLS [1]						
No. 1 wire and heavy copper	10,938	137,580	112,736	24,844	137,580	11,246
No. 2 wire, mixed heavy and light copper	4,316	43,061	41,851	1,210	43,061	4,415
Yellow brass	22,321	209,959	209,959	--	209,959	23,886
Cartridge cases and brass	8,543	55,987	55,471	516	55,987	8,090
Bronze	1,272	3,803	3,803	--	3,803	995
Nickel silver and cupronickel	7,110	39,233	39,233	--	39,233	7,228
Low brass	4,946	28,347	28,347	--	28,347	4,334
Aluminum bronze	29	394	394	--	394	34
Total [1]	59,475	518,364	491,794	26,570	518,364	60,228
FOUNDRIES, CHEMICAL PLANTS, AND OTHER MANUFACTURERS						
No. 1 wire and heavy copper	4,033	23,493	7,555	17,747	25,302	2,224
No. 2 wire, mixed heavy and light copper	1,222	9,587	2,284	7,791	10,075	734
Composition or red brass	879	4,320	1,522	3,170	4,692	507
Railroad-car boxes	278	4,904	--	4,585	4,585	597
Yellow brass	745	5,920	2,102	4,040	6,142	523
Auto radiators (unsweated)	1,136	7,737	--	7,662	7,662	1,211
Bronze	78	675	122	547	669	84
Nickel silver and cupronickel	--	10	--	10	10	--
Low brass	56	621	323	318	641	36
Aluminum bronze	59	269	45	224	269	59
Low-grade scrap and residues	373	[2] -229	51	--	51	93
Total	8,859	57,307	[3] 14,004	[3] 46,094	[3] 60,098	6,068
GRAND TOTAL						
No. 1 wire and heavy copper	20,232	286,104	170,256	115,691	285,947	20,697
No. 2 wire, mixed heavy and light copper	12,409	243,804	138,741	103,773	242,514	13,798
Composition or red brass	5,058	54,687	12,727	41,241	53,968	5,777
Railroad-car boxes	507	6,082	--	5,668	5,668	921
Yellow brass	28,259	254,456	216,879	37,890	254,769	29,511
Cartridge cases and brass	8,615	56,022	55,471	591	56,062	8,122
Auto radiators (unsweated)	4,701	53,906	--	53,321	53,321	5,286
Bronze	2,771	24,391	6,714	17,400	24,114	2,771
Nickel silver and cupronickel	7,941	41,986	39,562	2,466	42,028	8,017
Low brass	5,544	31,368	30,381	936	31,317	4,983
Aluminum bronze	182	1,099	664	338	1,002	284
Low-grade scrap and residues [4]	34,537	190,238	94,882	106,976	201,858	22,917
Total	130,756	1,244,143	766,277	486,291	1,252,568	123,084

[1] Brass-mill stocks include home scrap; purchased scrap consumption assumed equal to receipts, so lines in brass-mill and grand total sections do not balance.
[2] Negative receipts indicate shipments greater than receipts.
[3] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 1,214 tons new and 1,391 old.
[4] Includes refinery brass.

Table 24.—Consumption of copper and brass materials in the United States by principal consuming groups

(Short tons)

Year and item	Primary producers	Brass mills	Wire mills	Foundries, chemical plants, and miscellaneous users	Secondary smelters	Total
1974:						
Copper scrap	602,832	710,889	--	79,481	384,327	1,777,529
Refined copper [1]	--	670,158	1,474,340	40,486	9,184	2,194,168
Brass ingot	--	23,902	--	[2] 260,828	--	284,730
Slab zinc	--	170,669	--	3,631	7,263	181,563
Miscellaneous	--	--	--	200	13,167	13,367
1975:						
Copper scrap	372,505	518,364	--	60,098	301,601	1,252,568
Refined copper [1]	--	438,970	1,061,255	29,800	4,483	1,534,508
Brass ingot	--	5,645	--	[2] 188,669	--	194,314
Slab zinc	--	106,942	--	2,084	6,300	115,326
Miscellaneous	--	--	--	150	12,717	12,867

[1] Detailed information on consumption of refined copper will be found in table 28.
[2] Shipments to foundries by smelters plus decrease in stocks at foundries.

Table 25.—Foundry consumption of brass ingot, by type, in the United States

(Short tons)

	1971 r	1972 r	1973 r	1974 r	1975
Tin bronzes	36,755	40,526	47,963	53,702	40,982
Leaded red brass and semired brass	132,419	145,617	136,012	117,038	84,839
Yellow brass	34,681	36,865	34,820	58,922	65,799
Manganese bronze	8,257	9,933	10,868	9,773	6,843
Hardeners and master alloys	5,366	5,291	6,633	6,053	4,420
Nickel silver	3,466	2,838	2,908	3,104	2,437
Aluminum bronze	6,739	6,222	6,882	7,743	5,287
Total	227,683	247,292	246,086	256,335	210,607

r Revised.

Table 26.—Foundry consumption of brass ingot by type, refined copper, and copper scrap, in the United States in 1975, by geographic division and State

(Short tons)

Geographic division and State	Tin bronzes	Leaded red brass and semi-red brass	Yellow brass	Manganese bronze	Hardeners and master alloys	Nickel silver	Aluminum bronze	Total brass ingot	Refined copper consumed	Copper scrap consumed
New England:										
Connecticut	701	1,704	1,067	43	6	166	228	3,750	623	319
Massachusetts	866	3,708	614	235	13		58	5,659	700	25
Maine, New Hampshire, Rhode Island, Vermont	131	1,752	204	188	4	115	46	2,440		--
Total	1,698	7,164	1,885	466	23	281	332	11,849	1,323	344
Middle Atlantic:										
New Jersey	611	896	240	155	120	34	43	2,099	1,325	2,038
New York	1,830	5,869	844	293	64	194	116	9,210	1,438	1,356
Pennsylvania	6,296	6,869	1,690	583	1,152	319	1,397	18,306	4,957	4,529
Total	8,737	13,634	2,774	1,031	1,336	547	1,556	29,615	7,720	7,923
East North Central:										
Illinois	2,042	10,502	715	654	91	7	700	14,711	806	2,337
Indiana	2,606	5,565	838	359	1,151	282	43	10,844	993	7,075
Michigan	8,177	3,724	42,752	607	167	6	403	55,836	4,973	2,105
Ohio	8,177	8,929	4,173	1,245	299	19	447	23,289	3,347	5,969
Wisconsin	1,432	5,153	2,661	118	1,143	298	129	10,934	5,313	886
Total	22,434	33,873	51,139	2,983	2,851	612	1,722	115,614	15,432	18,372
West North Central:										
Iowa, Kansas, Minnesota	820	2,883	123	472	60	5	139	4,500	1,099	868
Missouri, Nebraska, South Dakota	126	753	826	194			17	1,918		711
Total	946	3,636	949	666	60	5	156	6,418	1,099	1,579
South Atlantic:										
Delaware, District of Columbia, Florida, Georgia, Maryland	431	364	103	100	3	784	69	1,852	142	679
North Carolina, South Carolina, Virginia, West Virginia	495	5,522	442	210			260	6,931	202	7,615
Total	926	5,886	545	310	3	784	329	8,783	344	8,294
East South Central:										
Alabama, Kentucky, Mississippi, Tennessee	2,215	7,674	3,166	523	56	74	102	13,810	1,389	7,528
West South Central:										
Arkansas, Louisiana, Oklahoma, Texas	2,371	2,092	3,758	347	3	76	865	9,512	1,293	898
Mountain:										
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah	263	389	57	36	4	--	8	757	298	468
Pacific:										
California	1,236	10,388	1,515	395	84	57	135	13,810	8	9,743
Oregon and Washington	156	103	11	86	--	1	82	439	427	2,344
Total	1,392	10,491	1,526	481	84	58	217	14,249	435	12,087
Grand total	40,982	84,839	65,799	6,843	4,420	2,437	5,287	210,607	29,333	57,493

Table 27.—Primary refined copper supply and withdrawals on domestic account

(Short tons)

	1971	1972	1973	1974	1975
Production from domestic and foreign ores, etc	1,591,782	1,873,233	1,868,488	1,654,658	1,443,378
Imports [1]	163,988	192,379	202,955	313,569	146,805
Stocks Jan. 1 [1]	130,000	75,000	57,000	37,000	101,000
Total available supply	1,885,770	2,140,612	2,128,443	2,005,227	1,691,183
Copper exports [1]	187,654	182,743	189,396	126,526	172,426
Stocks Dec. 31 [1]	75,000	57,000	37,000	101,000	207,000
Total	262,654	239,743	226,396	227,526	379,426
Apparent withdrawals on domestic account [2]	1,623,000	1,901,000	1,902,000	1,778,000	1,312,000

[1] May include some copper refined from scrap.
[2] Excludes copper, if any, delivered to industry from national stockpile sales.

Table 28.—Refined copper consumed by class of consumer

(Short tons)

Year and class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1974:							
Wire mills	365,111	1,101,675	W	--	--	7,554	1,474,340
Brass mills	205,803	32,023	117,791	177,663	136,878	--	670,158
Chemical plants	--	--	W	--	--	715	715
Secondary smelters	5,142	W	3,097	W	W	945	9,184
Foundries	1,725	1,508	15,494	W	W	631	19,358
Miscellaneous [1]	1,873	1,521	6,721	346	1,713	8,239	20,413
Total	579,654	1,136,727	143,103	178,009	138,591	18,084	2,194,168
1975:							
Wire mills	312,066	745,102	W	--	--	4,087	1,061,255
Brass mills	171,812	21,571	72,452	97,236	75,899	--	438,970
Chemical plants	--	--	--	--	--	467	467
Secondary smelters	2,542	W	1,931	--	W	10	4,483
Foundries	1,176	897	11,661	W	W	264	13,998
Miscellaneous [1]	2,742	217	5,421	214	178	6,563	15,335
Total	490,338	767,787	91,465	97,450	76,077	11,391	1,534,508

W Withheld to avoid disclosing individual company confidential data; included in "Other."
[1] Includes iron and steel plants, primary smelters producing alloys other than copper, consumers of copper powder and copper shot, and miscellaneous manufacturers.

Table 29.—Stocks of copper in the United States, Dec. 31

(Short tons)

Year	Blister and materials in process of refining [1]	Refined copper				
		Primary producers	Wire rod mills	Brass mills	Other [2]	New York Commodity Exchange
1971	303,000	75,000	93,000	40,000	6,000	20,300
1972	281,000	57,000	50,000	28,000	5,400	57,800
1973	265,000	37,000	42,000	30,000	5,600	5,900
1974	324,000	101,000	108,000	36,000	6,900	43,200
1975	312,000	207,000	119,000	31,000	6,100	100,000

[1] Includes copper in transit from smelters in the United States to refineries therein.
[2] Includes secondary smelters, chemical plants, foundries, and miscellaneous plants.

Table 30.—Dealers' monthly average buying price for copper scrap and consumers' alloy-ingot prices at New York in 1975
(Cents per pound)

Grade	Jan.	Feb.	Mar.	Apr.	May	June
No. 2 copper scrap	31.86	30.50	33.93	33.82	31.07	29.50
No. 1 composition scrap	29.32	28.50	32.79	34.50	34.07	32.31
No. 1 composition ingot	67,61	65.00	66.21	68.00	67.48	65.50
	July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Average**
No. 2 copper scrap	32.50	36.69	38.07	37.33	36.20	35.86	33.94
No. 1 composition scrap	31.91	34.69	34.93	32.94	32.20	31.50	32.47
No. 1 composition ingot	65.50	66.28	67.00	65.59	63.30	63.30	65.87

Source: Metal Statistics, 1976.

Table 31.—Average monthly quoted prices of electrolytic copper for domestic delivered, in the United States and for spot copper at London
(Cents per pound)

Month	1974			1975		
	Domestic delivered		London spot [1] Metals Week	Domestic delivered		London spot [1] Metals Week
	American Metal Market	Metals Week		American Metal Market	Metals Week	
January	68.70	68.75	92.12	68.86	69.03	54.91
February	68.70	68.58	103.80	64.32	64.18	57.44
March	68.70	68.58	124.44	64.32	64.18	60.85
April	68.70	68.58	137.50	64.32	64.18	60.28
May	81.19	81.46	130.35	64.32	63.78	56.81
June	86.09	86.24	110.60	63.67	63.14	54.04
July	86.31	86.60	87.03	63.02	62.48	55.43
August	86.31	86.60	81.74	64.31	63.79	57.91
September	83.01	83.66	66.20	64.31	63.79	54.86
October	78.23	78.43	63.40	64.31	63.79	53.46
November	75.79	76.25	64.13	64.31	63.79	53.44
December	73.03	73.57	58.43	64.31	63.79	52.18
Average	77.06	77.27	93.13	64.53	64.16	56.08

[1] Based on average monthly rates of exchange.

Table 32.—Average weighted prices of copper delivered
(Cents per pound)

Year	Domestic copper	Foreign copper
1971	52.0	49.3
1972	51.2	48.6
1973	59.5	80.8
1974	77.3	93.5
1975	64.2	56.0

Source: Metals Week.

Table 33.—U.S. exports of copper, by class and country

Year and country	Ore, concentrates, and matte (copper content)		Ash and residues (copper content)		Refined		Scrap		Blister	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1974	r 12,488	$17,387	8,233	$7,864	126,526	$227,704	41,342	$46,413	2,660	$3,568
1975:										
Africa	--	--	--	--	626	758	61	86	1	1
Argentina	--	--	--	--	55	68	453	538	--	--
Belgium-Luxembourg	297	121	2,322	2,385	13,154	17,118	3,998	3,105	887	542
Brazil	--	--	--	--	24,740	32,261	15	62	--	--
Canada	2,292	2,033	1,636	1,860	6,709	8,487	4,755	5,575	--	--
Denmark	--	--	--	--	772	864	--	--	--	--
Finland	--	--	--	--	926	1,101	--	--	--	--
France	--	--	--	--	22,753	31,860	101	90	--	--
Germany, West	--	--	455	536	34,117	40,636	4,184	3,825	--	--
India	--	--	--	--	119	125	46	46	--	--
Israel	--	--	--	--	10	19	--	--	--	--
Italy	--	--	82	69	22,156	31,487	702	587	(1)	1
Japan	4,741	3,943	163	283	2,999	3,823	7,118	7,220	52	70
Korea, Republic of	933	733	198	192	1,263	1,484	9,945	9,560	--	--
Mexico	--	--	--	--	31	73	1,104	845	2	2
Netherlands	--	--	676	416	14,906	19,575	558	519	--	--
Oceania	--	--	--	--	7	10	--	--	--	--
Pakistan	--	--	--	--	97	139	803	871	--	--
Philippines	--	--	--	--	1,740	2,467	--	--	--	--
Spain	--	--	58	22	133	137	3,882	2,715	54	103
Sweden	--	--	--	--	978	1,281	303	385	--	--
Switzerland	--	--	22	18	581	664	627	615	--	--
Taiwan	13	12	--	--	3,974	4,869	4,325	2,265	--	--
Thailand	--	--	--	--	649	806	136	139	--	--
United Kingdom	10	16	657	405	15,055	20,193	295	272	546	546
Venezuela	--	--	--	--	3,246	4,146	360	198	(1)	1
Other	21	59	330	81	630	967	1,231	1,275	3	4
Total	8,307	6,917	6,599	6,267	172,426	225,418	45,002	40,793	1,545	1,270

	Pipes and tubing		Plates and sheets		Wire and cable, bare		Wire and cable, insulated		Other copper manufactures [2]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1974	6,738	$18,376	793	$2,176	5,632	$11,438	62,514	$188,890	8,332	$17,583
1975:										
Africa	152	525	12	52	130	303	11,614	19,226	283	534
Argentina	--	--	2	7	(1)	6	45	273	98	257
Belgium-Luxembourg	1	4	--	--	23	94	254	1,458	139	236
Brazil	36	165	--	--	95	313	332	1,175	130	177
Canada	1,244	2,453	66	185	1,376	1,871	25,809	80,859	1,262	1,901
Denmark	--	--	--	--	(1)	1	152	898	84	94
Finland	1	2	--	--	4	7	14	153	44	82
France	79	289	2	10	4	21	221	1,874	220	416
Germany, West	18	39	4	8	30	121	167	1,720	2	8
India	(1)	2	--	--	--	--	65	440	(1)	1
Israel	32	79	1	2	36	237	427	2,318	11	33
Italy	(1)	1	7	29	31	110	143	1,694	26	168
Japan	64	736	12	38	11	54	202	1,502	120	199
Korea, Republic of	--	--	1	7	40	146	44	251	--	--
Mexico	48	129	11	45	559	1,576	8,732	17,564	61	93
Netherlands	(1)	1	7	37	20	49	469	2,318	64	76
Oceania	5	17	--	--	32	103	426	1,725	24	49
Pakistan	2	6	1	5	--	--	11	109	288	581
Philippines	12	28	6	32	6	31	1,105	2,550	79	108
Spain	(1)	1	--	--	60	282	199	1,273	317	362
Sweden	3	8	--	--	13	69	44	617	65	89
Switzerland	--	--	--	--	5	21	66	311	110	172
Taiwan	20	101	--	--	14	66	1,168	4,002	752	1,026
Thailand	1	2	--	--	1	8	92	351	8	15
United Kingdom	40	100	29	90	112	304	645	5,739	1,298	1,557
Venezuela	37	630	1	9	4	17	172	905	2,120	2,704
Other	407	962	24	90	1,115	3,456	27,012	72,638	1,913	3,220
Total	2,202	6,280	186	646	3,721	9,266	79,630	223,943	9,518	14,158

r Revised.
[1] Less than ½ unit.
[2] Does not include wire cloth: 1974, 1,954,750 square feet ($869,778); 1975, 2,268,914 square feet ($1,064,516).

Table 34.—U.S. exports of copper, by class

	Ore, concentrate and matte (copper content)		Blister		Refined copper and semimanufactures	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	23,508	$30,147	7,362	$8,069	242,856	$386,993
1974	r 12,488	r 17,387	2,660	3,568	202,203	448,584
1975	8,307	6,917	1,545	1,270	258,165	465,553

	Other copper manufactures[1]		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	7,431	$12,160	281,157	$437,369
1974	8,332	17,583	r 225,683	487,122
1975	9,518	14,158	277,535	487,898

r Revised.
[1] Does not include wire cloth; 1973, 2,017,365 square feet ($458,740); 1974, 1,954,750 square feet ($869,778); 1975, 2,268,914 square feet ($1,064,516).

Table 35.—U.S. exports of copper-base alloy (including brass and bronze), by class

Class	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Ingots	705	$1,972	304	$1,195
Scrap and waste	118,198	126,751	99,213	84,153
Bars, rods, shapes	15,227	31,189	7,754	13,197
Plates, sheets, strips	7,249	29,437	3,187	12,375
Pipes and tubing	8,026	23,907	6,609	19,193
Pipe fittings	9,827	31,409	6,953	23,146
Plumbers' brass goods	2,104	7,818	1,277	4,484
Welding rods and wire	4,190	13,987	2,477	7,939
Castings and forgings	987	2,409	997	3,181
Powder and flakes	2,722	7,243	1,266	2,901
Foil	286	1,453	217	796
Articles of copper and copper-base alloys, n.e.c.	([1])	7,264	([1])	7,278
Total	169,521	284,839	130,254	179,838

[1] Quantity not reported.

Table 36.—U.S. exports of unfabricated copper-base alloy[1] ingots, bars, rods, shapes, plates, sheets, and strip

Year	Quantity (short tons)	Value (thousands)
1973	15,253	$34,446
1974	23,181	62,598
1975	11,245	26,767

[1] Includes brass and bronze.

Table 37.—U.S. exports of copper sulfate (blue vitriol)

Year	Quantity (short tons)	Value (thousands)
1973	1,716	$2,043
1974	1,815	2,138
1975	1,248	2,067

Table 38.—U.S. exports of copper scrap, by country

Country	Unalloyed copper scrap				Copper alloy scrap			
	1974		1975		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	409	$920	453	$538	409	$577	2,035	$2,101
Belgium-Luxembourg	7,998	7,664	3,998	3,105	9,617	10,815	5,289	3,628
Brazil	658	1,157	15	62	3,253	4,789	310	280
Canada	8,652	10,563	4,755	5,575	9,120	10,118	6,838	6,307
Denmark	11	6	--	--	47	47	199	159
France	42	41	101	90	502	534	2,016	1,382
Germany, East	21	34	83	56	128	189	190	130
Germany, West	3,193	4,601	4,184	3,825	12,113	15,227	9,804	9,929
Hong Kong	207	290	644	668	626	739	821	706
India	--	--	46	46	--	--	1,543	1,396
Italy	837	909	702	587	18,285	19,641	11,862	9,371
Japan	2,157	2,763	7,118	7,220	24,779	29,077	23,038	20,045
Korea, Republic of	7,667	9,612	9,945	9,560	12,422	13,510	10,905	9,446
Mexico	1,185	1,527	1,104	845	311	290	303	236
Netherlands	773	679	558	519	3,609	4,177	2,705	2,455
Norway	323	394	115	119	60	81	167	160
Pakistan	--	--	803	871	62	67	1,829	1,650
Spain	2,042	1,529	3,882	2,715	4,120	4,023	5,823	5,203
Sweden	349	384	303	385	1,809	1,477	3,042	1,917
Switzerland	143	192	627	615	766	818	1,604	1,410
Taiwan	2,914	1,100	4,325	2,265	9,850	3,233	2,981	2,750
Thailand	--	--	136	139	--	--	2,586	515
United Kingdom	741	1,055	295	272	5,192	6,713	2,421	2,428
Venezuela	852	736	360	198	615	138	429	121
Other	168	257	450	518	503	471	473	428
Total	41,342	46,413	45,002	40,793	118,198	126,751	99,213	84,153

Table 39.—U.S. imports for consumption of copper scrap, by country

Country	Unalloyed copper scrap (copper content)			
	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	198	$310	77	$84
Bahamas	21	16	11	8
Belgium-Luxembourg	826	1,400	59	96
Canada	12,779	22,279	7,679	7,663
Chile	242	479	24	25
Dominican Republic	386	535	329	286
France	290	638	226	533
Germany, West	1,427	2,691	87	107
Guatemala	52	131	65	37
Honduras	42	62	65	53
Hong Kong	1,137	1,325	76	84
Jamaica	113	145	125	77
Japan	4,259	8,245	37	86
Mexico	6,188	7,407	4,202	3,844
Netherlands	484	884	129	233
Netherlands Antilles	217	279	272	265
Nicaragua	361	556	30	28
Panama	275	365	231	220
Switzerland	327	577	--	--
Trinidad and Tobago	19	28	36	29
United Kingdom	214	442	46	54
Other	1,252	r 1,847	593	647
Total	31,109	r 50,641	14,399	14,459

Country	Copper alloy scrap					
	1974			1975		
	Gross weight (short tons)	Content weight (short tons)	Value (thousands)	Gross weight (short tons)	Content weight (short tons)	Value (thousands)
Australia	40	38	$50	16	10	$24
Bahamas	183	119	108	170	106	101
Belgium-Luxembourg	82	58	89	242	130	194
Canada	11,507	7,565	16,443	6,820	4,461	5,828
Dominican Republic	166	123	161	132	94	81
Germany, West	236	143	301	60	31	49
Guatemala	61	46	43	9	6	4
Haiti	29	22	34	18	13	13
Hong Kong	1,057	721	1,531	320	206	481
Israel	59	52	71	--	--	--
Jamaica	30	20	26	2	1	1
Japan	564	320	578	--	--	--
Mexico	754	510	721	723	474	449
Netherlands	181	135	268	--	--	--
Netherlands Antilles	172	96	132	14	10	9
Nicaragua	55	38	53	4	3	3
Panama	78	59	88	177	115	149
Poland	--	--	--	221	115	186
Sudan	87	61	130	--	--	--
Switzerland	295	183	365	--	--	--
Trinidad and Tobago	83	67	98	24	17	10
United Kingdom	21	13	30	--	--	--
Other	150	108	181	59	39	57
Total	15,890	10,497	21,501	9,011	5,831	7,639

r Revised.

Table 40.—U.S. imports[1] of unmanufactured copper (copper content), by class and country

Year and country	Ore, concentrates		Matte		Blister		Refined		Scrap		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	43,335	$54,707	746	$542	154,104	$198,790	202,955	$262,129	19,373	$23,979	420,513	$540,147
1974:												
Australia	2,379	3,219	--	--	--	--	83	140	198	310	2,660	3,669
Belgium-Luxembourg	--	--	--	--	--	--	8,024	15,915	826	1,400	8,850	17,315
Botswana	--	--	625	3,018	--	--	--	--	--	--	625	3,018
Canada	19,907	26,876	155	81	3	4	118,429	190,373	12,828	22,355	151,322	239,689
Chile	--	--	7	14	65,093	126,897	66,549	119,837	242	479	131,891	247,227
France	--	--	--	--	--	--	664	1,343	290	638	954	1,981
Germany, West	--	--	--	--	--	--	7,177	13,290	1,427	2,691	8,604	15,981
Honduras	4,595	1,695	--	--	--	--	--	--	42	62	4,637	1,757
Hong Kong	--	--	--	--	--	--	22	34	1,137	1,325	1,159	1,359
Japan	--	--	--	--	94	231	73,055	136,988	4,259	8,245	77,408	145,464
Kenya	--	--	--	--	3,081	5,461	--	--	85	126	3,166	5,587
Mexico	2,069	1,288	--	--	7,644	17,396	873	1,396	6,188	7,407	16,774	27,487
Netherlands	--	--	--	--	17	5	3,253	5,651	484	884	3,754	6,540
Nicaragua	2,771	1,034	--	--	--	--	--	--	361	556	3,132	1,590
Norway	--	--	--	--	--	--	294	666	39	72	333	738
Peru	7,284	14,918	--	--	94,686	171,612	6,913	12,495	22	32	108,905	199,057
Philippines	14,244	27,206	--	--	--	--	--	--	34	55	14,278	27,261
Poland	--	--	--	--	--	--	2,192	4,162	--	--	2,192	4,162
South Africa, Republic of	--	--	1,754	9,080	37,211	71,946	110	143	--	--	39,075	81,169
U.S.S.R	--	--	--	--	--	--	1,102	1,762	--	--	1,102	1,762
United Kingdom	166	265	--	--	1	1	6,643	13,044	214	442	7,024	13,752
Yugoslavia	--	--	--	--	--	--	14,844	28,357	222	100	15,066	28,457
Zambia	--	--	--	--	--	--	2,825	5,160	--	--	2,825	5,160
Other	6	3	83	100	--	--	517	970	2,260	3,538	2,866	4,611
Total	53,421	76,504	2,624	12,293	207,830	393,553	313,569	551,726	31,158	50,717	608,602	1,084,793
1975:												
Australia	2,134	1,723	--	--	7	13	1,273	1,409	77	84	3,491	3,229
Belgium-Luxembourg	--	--	--	--	(2)	1	7,405	8,204	59	96	7,464	8,301
Botswana	--	--	5,489	20,374	--	--	--	--	--	--	5,489	20,374
Canada	38,958	46,922	75	29	4	4	70,747	88,484	7,679	7,663	117,463	143,102
Chile	18	(2)	19	35	26,283	27,007	28,626	30,378	24	25	54,970	57,445
Honduras	2,094	706	--	--	--	--	--	--	65	53	2,159	759
Japan	9	10	27	24	--	--	8,259	10,469	37	86	8,332	10,589
Mexico	2,461	1,054	--	--	8,822	11,598	912	993	4,202	3,844	16,397	17,489
Nicaragua	410	421	--	--	--	--	--	--	30	28	440	449
Norway	--	--	--	--	--	--	242	292	--	--	242	292

See footnotes at end of table.

Table 40.—U.S. imports[1] of unmanufactured copper (copper content), by class and country—Continued

Year and country	Ore, concentrates		Matte		Blister		Refined		Scrap		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1975—Continued												
Peru	6,077	$6,746	--	--	30,951	$32,423	6,864	$7,011	--	--	43,892	$46,180
Philippines	12,601	14,199	--	--	--	--	--	--	--	--	12,601	14,199
Poland	117	40	--	--	--	--	--	--	--	--	117	40
South Africa, Republic of	--	--	3,153	14,451	2,470	2,679	--	--	--	--	5,623	17,130
South West Africa	--	--	--	--	20,414	23,154	--	--	--	--	20,414	23,154
United Kingdom	--	--	1	10	--	--	771	1,157	46	54	818	1,221
Yugoslavia	--	--	--	--	--	--	21,494	21,347	--	--	21,494	21,347
Other	(2)	(2)	328	858	--	--	212	342	2,180	2,526	2,720	3,726
Total	64,879	71,821	9,092	35,781	88,951	96,879	146,805	170,086	14,399	14,459	324,126	389,026

[1] Data are general imports, that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Less than ½ unit.

Table 41.—U.S. imports for consumption of copper (copper content) by class

Year	Ore and concentrates: Quantity (short tons)	Ore and concentrates: Value (thousands)	Matte: Quantity (short tons)	Matte: Value (thousands)	Blister: Quantity (short tons)	Blister: Value (thousands)
1973	19,582	$16,029	139	$106	128,166	$159,922
1974	^{r} 84,728	^{r} 121,422	2,426	12,033	200,607	383,491
1975	29,301	35,649	5,675	20,560	78,969	90,846

Year	Refined: Quantity (short tons)	Refined: Value (thousands)	Scrap: Quantity (short tons)	Scrap: Value (thousands)	Total value (thousands)
1973	207,739	$264,967	19,018	$23,540	$464,564
1974	313,349	551,442	31,109	^{r} 50,641	^{r} 1,119,029
1975	142,945	166,159	14,399	14,459	327,673

^{r} Revised.

Table 42.—Copper: World mine production, by country [1]

(Short tons)

Country	1973	1974	1975 ^{p}
North and Central America:			
Canada [2]	^{r} 908,241	905,416	798,132
Cuba ^{e}	^{r} 2,300	^{r} 6,600	5,500
Dominican Republic	^{e} 500	^{e} 500	--
Mexico	88,737	91,128	86,196
Nicaragua [3]	1,703	1,957	711
United States [2]	1,717,940	1,597,002	1,413,366
South America:			
Argentina	313	347	202
Bolivia [4]	9,432	8,940	7,045
Brazil	3,761	3,390	^{e} 3,300
Chile	810,639	994,394	913,043
Colombia ^{e}	80	80	80
Ecuador	335	197	263
Peru	^{r} 223,423	233,241	[2] 197,340
Europe:			
Albania ^{e} [5]	7,690	8,540	8,540
Austria	^{r} 3,023	2,962	2,186
Bulgaria	^{r} 52,911	55,160	52,900
Czechoslovakia	^{r} 4,960	^{e} 5,000	^{e} 5,000
Finland	41,192	39,850	42,770
France	456	432	241
Germany, East ^{e}	1,700	--	--
Germany, West [2 6]	1,583	1,911	2,162
Greece	1,587	^{e} 3,300	^{e} 3,300
Hungary ^{e}	1,300	1,300	1,300
Ireland [3]	^{r} 14,338	14,000	10,800
Italy [6]	946	915	1,011
Norway [6]	^{r} 24,521	22,417	30,260
Poland	170,900	218,300	297,600
Portugal [6]	6,409	6,226	5,577
Romania ^{e} [2]	46,300	55,100	55,100
Spain [6 7]	42,420	37,807	23,545
Sweden	49,404	44,795	44,823
U.S.S.R. ^{e} [2 5]	772,000	816,000	843,000
United Kingdom	506	478	^{e} 440
Yugoslavia	^{r} 123,235	123,587	126,722
Africa:			
Algeria	389	^{e} 410	^{e} 440
Botswana	^{e} 1,500	2,623	7,154
Congo (Brazzaville) [3]	1,022	1,025	1,010
Ethiopia ^{e}	440	440	440
Kenya ^{e}	^{r} 80	^{r} 80	80
Mauritania	23,454	22,133	17,861
Morocco [3]	4,762	5,952	5,291
Mozambique [3]	441	689	^{e} 850
Rhodesia, Southern [8]	46,100	43,315	^{e} 43,000
South Africa, Republic of	193,783	197,436	197,233
South-West Africa, Territory of [3 9]	37,664	35,801	43,028
Uganda	17,259	13,496	9,370
Zaire	^{r} 538,552	550,524	547,111
Zambia	778,864	769,364	746,177

See footnotes at end of table.

Table 42.—Copper: World mine production, by country [1]—Continued

(Short tons)

Country	1973	1974	1975 p
Asia:			
Burma [10]	77	77	94
China, People's Republic of e	110,000	110,000	110,000
Cyprus [6]	r 15,672	10,830	10,882
India	r 18,916	30,953	42,990
Indonesia	r 41,780	71,210	68,450
Iran [11]	3,300	1,980	2,650
Israel	11,202	12,100	8,270
Japan [3] [12]	r 123,994	90,538	93,011
Korea, North e	14,000	14,000	14,000
Korea, Republic of	2,558	3,080	2,944
Malaysia e	55	r 55	40
Philippines	243,825	248,554	249,894
Taiwan e	2,650	2,760	2,760
Turkey	r 33,290	42,765	40,319
Oceania:			
Australia	r 242,877	277,055	240,821
New Zealand	(13)	--	--
Papua New Guinea [3]	r 201,610	202,940	190,123
Total	r 7,844,901	8,063,457	7,678,948

e Estimate. p Preliminary. r Revised.

[1] Data shown represent copper content (recoverable where indicated) of ore mined wherever possible. If such data are not available, the nonduplicative total copper content of ores, concentrates, matte, metal and/or other copper-bearing products measured at the least stage of processing for which data are available has been used.

[2] Recoverable.

[3] Copper content of concentrate produced.

[4] Corporación Minera de Bolivia (COMIBOL) production plus exports by medium and small mines.

[5] Smelter production.

[6] Includes copper content of cupriferous pyrites.

[7] Excludes an unreported quantity of copper in iron pyrites which may not be recovered.

[8] Year ending September 30 of that stated.

[9] Data are compiled from operating company reports of Tsumeb Corp. Ltd., General Mining and Finance Corp. Ltd. for Klein Aub Koper Maatskappy Ltd.'s mine near Rehoboth, and Falconbridge Nickel Mines Ltd. for Oamites Mining Company (Pty.) Ltd., Oamites mine. Data for General Mining and Finance Corp. Ltd. are for fiscal years ending June 30 of that stated, while data from other companies are for calendar years.

[10] Copper content of matte produced.

[11] Year beginning March 21 of that stated.

[12] Copper content of run-of-mine production was as follows in short tons: 1973—r 103,874; 1974—90,985; 1975—93,952.

[13] Revised to zero.

Table 43.—Copper: World smelter production, by country [1]

(Short tons)

Country	1973	1974	1975 p
North America:			
Canada	545,641	591,990	551,152
Mexico [2]	80,506	86,322	84,188
United States [3]	1,743,963	1,569,816	1,447,128
South America:			
Argentina e	90	90	90
Brazil	4,630	2,756	e 2,700
Chile [4]	650,253	798,403	798,513
Peru	r 190,650	194,560	173,081
Europe:			
Albania e	r 7,690	r 8,540	8,540
Austria	330	2,870	e 2,870
Belgium [5]	17,600	17,600	16,500
Bulgaria e	58,000	r 53,000	62,000
Czechoslovakia	7,700	6,600	6,600
Finland	45,836	48,569	51,731
Germany, East e	1,650	--	--
Germany, West	r 175,501	191,834	185,326
Hungary e	1,300	1,300	1,300
Norway [6]	r 38,193	34,984	29,044
Poland [7]	r 172,000	215,000	273,400
Portugal	r 4,080	3,970	4,400
Romania e	46,300	55,100	55,100
Spain	r 104,482	142,443	157,410
Sweden	48,875	45,125	45,793
U.S.S.R. e	772,000	816,000	843,000
Yugoslavia	r 176,397	195,063	178,574

See footnotes at end of table.

Table 43.—Copper: World smelter production, by country [1]—Continued

(Short tons)

Country	1973	1974	1975 p
Africa:			
Rhodesia, Southern e 8	r 40,800	r 45,200	47,400
South Africa, Republic of	165,790	162,920	165,020
South-West Africa, Territory of 9	39,737	51,381	40,135
Uganda	10,684	9,827	8,800
Zaire 10	507,591	517,980	509,930
Zambia	759,024	781,828	726,453
Asia:			
China, People's Republic of e	110,000	110,000	110,000
India	12,070	12,100	12,100
Iran 11	2,200	7,170	6,600
Japan	1,102,885	1,049,955	905,496
Korea, North e	14,000	14,000	14,000
Korea, Republic of	8,490	13,670	23,100
Taiwan 11	3,970	4,400	4,400
Turkey	28,372	32,603	29,707
Oceania: Australia	r 179,200	215,853	198,327
Total	r 7,878,480	8,110,822	7,779,908

e Estimate. p Preliminary. r Revised.

1 Unless otherwise noted, data presented for each country represent primary copper metal output, whether produced by thermal or electrowinning. To the extent possible, refined copper produced from imported blister or electrolytic anode copper has been excluded.

2 Copper content of impure bars and electrolytic copper.

3 Smelter output of domestic and foreign ores, exclusive of that from scrap. Production from domestic ores only was as follows in short tons: 1973—1,705,065; 1974—1,532,066; 1975—1,374,324.

4 Figures presented are total blister and equivalent copper output including that blister subsequently refined in Chile and copper which is produced by electrowinning. Material produced for refining at Ventanas smelter is included.

5 Belgium reports a large output of refined copper, but this is produced mainly from imported blister; domestic smelter production is reported output of blister copper from ores.

6 Reported Norwegian copper output is derived in part from copper-nickel matte imported from Canada, and reported Canadian smelter production may also include this material. Norwegian smelter output from domestic ores was as follows (approximately) in short tons: 1973—7,500; 1974—6,500; 1975—7,500.

7 Refined output.

8 Year ending September 30 of that stated.

9 Data from Tsumeb Corp., Ltd.

10 Data include refined copper plus exported blister and leach cathodes.

11 Includes secondary.

Table 44.—Copper: World refinery production, by country [1]

(Short tons)

Country	1973	1974	1975 p
North America:			
Canada 2	548,489	616,329	583,350
Mexico	63,065	75,179	69,610
United States	1,868,488	1,654,658	1,443,378
South America:			
Argentina	90	90	90
Brazil 2	r 32,740	41,120	31,750
Chile 3	r 457,240	593,150	589,960
Peru	r 42,965	42,940	58,390
Europe:			
Albania e	7,690	8,540	8,540
Austria	25,215	29,446	29,686
Belgium 4	r 416,673	437,253	393,548
Bulgaria e	52,900	52,900	52,900
Czechoslovakia 2	r 19,665	22,981	19,800
Finland	47,297	42,193	39,423
France	e 23,800	24,866	21,491
Germany, East e	46,300	50,700	52,900
Germany, West 2	448,263	466,896	465,397
Hungary e 2	19,000	19,000	19,000
Norway	r 28,456	27,345	21,687
Poland	r 172,000	215,000	273,400
Portugal	2,551	2,777	e 2,800
Romania e	46,300	55,100	55,100
Spain	r 134,923	160,055	140,214
Sweden	52,760	52,335	e 49,600
U.S.S.R.e	733,000	777,000	800,000
United Kingdom	83,619	76,165	83,226
Yugoslavia	r 147,334	154,038	136,562

See footnotes at end of table.

Table 44.—Copper: World refinery production, by country [1]—Continued

(Short tons)

Country	1973	1974	1975 p
Africa:			
Rhodesia, Southern e	33,000	33,000	33,000
South Africa, Republic of	99,870	97,550	95,240
Zaire [5]	246,429	280,617	249,012
Zambia	703,835	746,103	693,518
Asia:			
China, People's Republic of e	130,000	r 165,000	165,000
India	r 13,241	12,976	18,016
Iran e	r 7,700	r 7,700	7,700
Japan	1,048,057	1,097,955	902,442
Korea, North e	14,000	14,000	14,000
Korea, Republic of [2]	10,192	13,668	23,069
Taiwan	7,329	10,868	9,413
Turkey	r 16,500	32,630	17,600
Oceania: Australia	r 160,160	179,082	182,257
Total	r 8,011,136	8,389,205	7,852,069

e Estimate. p Preliminary. r Revised.

[1] Unless otherwise noted, data presented for each country represent total primary refined copper (both fire refined and electrolytically refined), including refined from imported crude copper (blister and electrolytic anode).

[2] Includes secondary.

[3] Includes electrolytic output of Ventanas refinery.

[4] Data include leach cathodes from Zaire, secondary and alloy material.

[5] Excludes metal content of leach cathodes which are included in Belgium production.

Diatomite

By Arthur C. Meisinger [1]

U.S. production of processed diatomite in 1975 declined 14% in quantity and 10% in value compared with that of 1974. The weighted average price per ton, however, increased from $76.31 in 1974 to $80.01 in 1975, to offset increased costs of energy consumption in the industry's processing plants. Exports of processed diatomite also decreased 21% in quantity and 13% in value, but imports showed a slight increase in 1975.

DOMESTIC PRODUCTION

Domestic production of processed diatomite in 1975 was 572,582 tons, or about 14% below the 1974 figure. However, value of diatomite sales in 1975 increased by approximately $3.70 per ton over that of 1974, primarily owing to continued increases in fuel costs at diatomite processing plants.

During the year, 11 companies operated 15 mine and plant facilities (one less than in 1974, revised) to produce diatomite in 5 States—California, Kansas, Nevada, Oregon, and Washington. Domestic producers in 1975 were: Johns-Manville Sales Corp., with operations at Lompoc, Calif.; Grefco, Inc., Lompoc, Calif. and Mina, Nev.; Excel-Minerals Co., Taft, Calif.; Airox Earth Resources, Inc., Santa Maria, Calif.; NL Industries, Inc., near Wallace, Kans.; Eagle-Picher Industries, Inc., with facilities at Sparks and Lovelock, Nev.; Cyprus Mines Corp., Fernley, Nev.; A. M. Matlock and American Fossil, Inc., both with operations in Christmas Valley, Oreg.; and Witco Chemical Corp. Inorganic Specialties Division, at Quincy, Wash.

Table 1.—Diatomite sold or used by producers in the United States

	1971	1972	1973	1974	1975
Domestic production (sales) --- short tons --	535,318	576,089	608,906	664,303	572,582
Average value per ton	$64.25	$65.19	$59.26	$76.31	$80.01

CONSUMPTION AND USES

Compared with 1974, all reported end uses of diatomite showed declines in quantities consumed with the exception of abrasives and lightweight aggregates. Filtration, which continued to be the major end use, accounted for 60% of domestic demand in 1975. Fillers were the second most important end use followed by lightweight aggregates, coating agents, and insulation. Other uses included abrasives, absorbents, inert carriers, paint additives, pozzolan, and silicate admixtures.

[1] Industry economist, Division of Nonmetallic Minerals.

Table 2.—Domestic consumption of diatomite, by principal use
(Percent of total consumption)

Use	1971	1972	1973	1974	1975
Filtration	59	58	61	60	60
Fillers	W	W	W	W	W
Insulation	3	4	4	5	4
Miscellaneous	38	38	35	35	36

W Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."

PRICES

The weighted average price per ton of processed diatomite sold by producers was $80.01 in 1975 compared with $76.31 in 1974. Price increases were substantial for all major end use categories in 1975 (table 3), with the exception of miscellaneous uses of diatomite, which showed a decrease of $0.62 per ton from that reported in 1974.

Table 3.—Average annual value per ton of diatomite, by use

Use	1974	1975
Filtration	$87.40	$91.73
Insulation	55.59	62.61
Abrasives	129.51	145.56
Fillers	77.12	79.66
Lightweight aggregate	47.31	52.69
Miscellaneous	46.25	45.63
Weighted average	76.31	80.01

FOREIGN TRADE

Exports of prepared diatomite decreased 21% in quantity and 13% in value from that of 1974, and the quantity exported (147,000 tons) represented 26% of domestic production (573,000 tons) in 1975. Principal countries of destination were Canada, 42,715 tons; the United Kingdom, 14,431 tons; Japan, 10,714 tons; West Germany, 10,333 tons; and Australia, 8,293 tons. The average value of exports was $104.18 per ton compared with $94.31 in 1974. Imports of diatomite in 1975 totaled 3,833 tons, nearly all from Mexico (99%).

Table 4.—U.S. exports of diatomite
(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	178	14,532
1974	186	17,541
1975	147	15,314

Table 5.—Diatomite: World production, by country
(Short tons)

Country	1973	1974	1975 [p]
North America:			
Canada [e]	[r] 550	[r] 550	550
Costa Rica	[r] 33,069	[e] 39,000	[e] 39,000
Mexico	21,560	26,048	25,048
United States	608,906	664,303	573,000
South America:			
Argentina	17,989	7,988	[e] 7,700
Chile	5,361	2,524	205
Colombia	386	606	[e] 600
Peru	3,839	[r] [e] 3,900	[e] 3,900
Europe:			
Austria	2,353	2,189	1,736
Denmark:			
Diatomite [e]	22,000	22,000	23,000
Moler [e]	240,000	240,000	250,000
France [e]	220,000	230,000	230,000
Germany, West (marketable)	50,144	47,213	44,000
Iceland	24,582	[e] 24,800	[e] 24,800
Italy [e]	65,000	65,000	67,000
Portugal	1,271	2,090	2,304
Spain	[r] 21,339	[r] [e] 22,000	[e] 22,000
Sweden	489	624	[e] 660
U.S.S.R. [e]	430,000	440,000	450,000
United Kingdom	4,409	4,400	[e] 4,400
Africa:			
Algeria [e]	5,100	5,100	5,100
Egypt	1,764	1,764	454
Kenya	[r] 1,368	1,827	1,983
South Africa, Republic of	582	866	715
Asia:			
Korea, Republic of	4,389	[e] 4,400	2,620
Oceania:			
Australia	[r] 5,073	1,067	[e] 5,500
New Zealand	4,962	5,024	[e] 5,100
Total	[r] 1,796,485	1,865,283	1,791,375

[e] Estimate. [p] Preliminary. [r] Revised.

Feldspar, Nepheline Syenite and Aplite

By J. Robert Wells [1]

Activity in the feldspar industry was at a comparatively low level in 1975, with both production and consumption significantly below the figures recorded in 1974. Although utilization of the mineral in making container glass held up well during the year, the general trend was downward, largely because the slack in housing construction slowed sales of window glass and some ceramics—floor and wall tile, and electrical and sanitary porcelains—weakening demand for feldspar in those applications. Even in the face of lagging demand, feldspar prices rose sharply during the year, yielding to the upward pressure of rising production costs—notably greater outlays for fuels, equipment, and supplies reinforced by the increasing expense of complying with environmental regulations.

Legislation and Government Programs.—According to provisions of the Tax Reform Act of 1969, which continued in force throughout 1975, the depletion rate allowed on feldspar production (both domestic and foreign operations) was 14%.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient feldspar statistics

		1971	1972	1973	1974	1975
United States:						
Unground: [1]						
Sold or used by producers	short tons	742,810	746,212	791,900	r 762,723	669,898
Value	thousands	$9,969	$10,633	$12,830	r $11,396	$11,728
Imports for consumption	short tons	134	187	264	30	209
Value	thousands	$19	$23	$22	$1	$17
Sold to consumers	short tons	NA	175,526	179,732	220,326	118,309
Value	thousands	NA	$1,257	$1,862	r $3,082	$2,323
Consumption, apparent [2]	short tons	742,944	746,399	792,164	r 762,753	670,107
Ground:						
Sold by merchant mills	short tons	601,618	580,801	588,698	r 547,833	541,577
Value	thousands	$8,716	$8,990	$10,628	r $11,421	$12,286
Exports	short tons	3,984	5,275	9,554	18,319	9,543
Value	thousands	$141	$184	$466	$662	$507
Imports for consumption	short tons	2,375	945	103	62	81
Value	thousands	$65	$20	$4	$3	$6
World production	thousand short tons	2,815	2,994	r 3,050	r 3,310	3,041

r Revised. NA Not available.
[1] Includes hand-cobbed feldspar, flotation-concentrate feldspar, and feldspar in feldspar-silica mixtures.
[2] Measured by quantity sold or used plus imports.

FELDSPAR

DOMESTIC PRODUCTION

Unground Feldspar.—The 1975 domestic output of feldspar ready to be put into final form for use (that is, the total quantity of hand-cobbed feldspar, flotation-concentrate feldspar, and feldspar content of feldspar-silica mixtures) was 12% less in tonnage than in 1974 but 3% higher in total value. Feldspar was mined in eight States with North Carolina in the lead, followed in descending order by Connecticut, California, Georgia, South Dakota, Arizona, Wyoming, and Colorado. The combined outputs of the first four States named amounted to 97% of the U.S. total. It should be noted that in 1975 the production of hand-cobbed feldspar sank to the lowest level in the 20 years for which comparable data have been recorded.

Ground Feldspar.—Most of the feldspar used in glassmaking is ground no finer than 20 mesh, and substantial tonnages of feldspathic sands (feldspar-silica mixtures) enter into glass furnace feeds with no further reduction in particle size; feldspar to be used in ceramics and filler applications is usually pulverized to minus 200 mesh or finer. In 1975, 8 U.S. companies operated 10 plants in 7 States to grind feldspar for shipment to destinations in at least 21 States, Puerto Rico, Canada, and Mexico. The Oxford Feldspar Corp. mill at West Paris, Maine, was activated in 1975 to produce dry-ground feldspar for ceramic purposes, an event that may possibly foreshadow resumption of feldspar mining in that State (inactive since 1970) or in New Hampshire (inactive since 1969).

Table 2.—Unground feldspar sold or used by producers in the United States
(Thousand short tons and thousand dollars)

Year	Hand-cobbed		Flotation concentrate		Feldspar-silica mixtures [1]		Total [2]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1971	45	749	443	5,454	255	3,766	743	9,969
1972	39	653	535	7,354	172	2,627	746	10,633
1973	53	636	546	9,789	193	2,406	792	12,830
1974 [r]	46	412	580	8,784	137	2,199	763	11,396
1975	17	274	531	9,260	122	2,193	670	11,728

[r] Revised.
[1] Feldspar content.
[2] Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Unground Feldspar.—In 1975 there was as usual no significant consumption of feldspar in the raw, unprocessed state in which it is taken from the mine. The majority of users acquired their supplies already ground and sized either by the primary producers or by merchant grinders, although some manufacturers of pottery, soaps, and enamels continued their customary practice of purchasing crude feldspar for grinding to their preferred specifications in their own mills. The Bureau of Mines canvass of producers and merchant grinders does not provide information concerning the end use distribution of the material handled in this way. It should be noted that a substantial portion of the material classified as feldspar-silica mixtures serves in glassmaking without additional processing, so that this utilization might properly be considered as consumption of unground feldspar.

Ground Feldspar.—The 1975 end use distribution of ground feldspar in the United States indicated that 51% of the total was consumed in glassmaking and 39% was used in pottery. The remaining 10% was used in a diversity of applications, including glazes, enamels, soaps, abrasives, sanitary ware, rubber products, and electrical insulators.

Table 3.—Ground feldspar sold by merchant mills, by use

Use	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Hand-cobbed:				
Glass	100	$4	100	$4
Pottery	35,742	1,153	11,899	405
Other	14,382	480	4,811	175
Total	50,224	1,637	16,810	584
Flotation concentrate:				
Glass	198,242	3,112	254,141	4,733
Pottery	219,295	4,882	172,999	4,806
Other	22,827	732	20,019	661
Total	440,364	8,726	447,159	10,200
Feldspar-silica mixtures: [1]				
Glass	--	--	24,156	266
Pottery	39,414	658	25,870	430
Other	17,831	401	27,582	806
Total	57,245	1,059	77,608	1,502
Total:				
Glass	198,342	3,116	278,397	5,003
Pottery	294,451	6,693	210,768	5,641
Other [2]	55,040	1,613	52,412	1,642
Total	547,833	[3] 11,421	541,577	12,286

[1] Feldspar content.
[2] Includes soaps, abrasives, sanitary ware, rubber, and electrical insulators.
[3] Data do not add to total shown because of independent rounding.

STOCKS

From a comparison of 1975 data on domestic production and sales of feldspar, it was estimated that U.S. producers had 239,000 tons of feldspar (unground, ground, or in process) on hand on December 31, 1975.

PRICES

Engineering and Mining Journal, December 1975, listed the following prices for feldspar, per short ton, f.o.b. mine or mill, carload lots, bulk, depending on grade (prices were generally about $2.50 per ton higher than the corresponding quotations of the preceding year):

North Carolina:	
20 mesh, flotation	$17.50
40 mesh, flotation	$18.00– 27.25
200 mesh, flotation	27.25– 34.00
Georgia:	
40 mesh, granular	26.00
200 mesh	33.00
Connecticut:	
20 mesh, granular	20.00– 22.50
200 mesh	28.00– 30.00

Feldspar prices were quoted by Industrial Minerals (London), December 1975, as follows (converted from pounds sterling per long ton to dollars per short ton):

Ceramic grade, powder, 200 mesh, bagged, ex-store	$59–$66
Sand, 2–3 mm, ceramic and/or glass grade, c.i.f. main European port	41– 51

No explanation was offered for the fact that the ceramic-grade quotations were about 25% lower than their respective 1974 counterparts, while those for ceramic and/or glass material were 30% higher.

FOREIGN TRADE

In 1975, U.S. exports classified as feldspar, leucite, and nepheline syenite (but presumably all or mostly feldspar) amounted to 9,543 tons valued at $506,834, approximately half the comparable figure reported in 1974. Chief recipients of the exported material were Canada, 72%; Mexico, 22%; and Taiwan, 3%. The remaining 3% was shared among nine other countries.

U.S. imports for consumption of feldspar in 1975, although notably higher than in 1974, still amounted to only a small fraction of the quantity exported (3% of the tonnage, 5% of the total value). In addition to feldspar and nepheline syenite, U.S. imports in 1975 included 1,371 tons of material, probably feldspathic in nature, that was classified as "Natural mineral fluxes, crude, crushed, ground, or pulverized" with a total value of $229,786.

The tariff schedule in force throughout 1975 provided for a 3½% ad valorem duty on ground feldspar; imports of unground feldspar were admitted duty-free.

Table 4.—U.S. imports for consumption of feldspar

Country	1974		1975	
	Quantity (short tons)	Value	Quantity (short tons)	Value
Crude:				
Canada	30	$617	--	--
South Africa, Republic of	--	--	[1]209	$17,188
Total	30	617	209	17,188
Ground, crushed, or pulverized:				
Canada	23	915	--	--
Sweden	39	2,533	79	5,800
United Kingdom	--	--	2	450
Total	62	3,448	81	6,250

[1] Adjusted by Bureau of Mines.

WORLD REVIEW

Finland.—The name of Finland's only feldspar producer, which operates a flotation process on Kimito Island, was changed in October 1975 from Lohjan Kalkkitehdas Oy (or Lojo Kalkverk AB) to Oy Lohja AB Minerals. An expansion was begun to increase the company's production capacity from the current 75,000 tons per year to 83,000 tons per year, of which it is estimated that about 75% will be exported to the United Kingdom, other European countries, and the Far East.

France.—In July 1975, Denain Anzin Minéraux (DAM) took over controlling interests in two other firms, Société Sipo and Société des Feldspaths du Midi, thus becoming the largest feldspar producer in the nation. DAM's current production consists of about 11,000 tons per year of glass-grade soda spar and 7,000 tons per year of potash spar for use in enamels and electrical porcelain.

Germany, West.—The combined outputs of some 15 large firms distributed throughout the country place West Germany unchallenged at the head of Europe's feldspar-producing nations. Even so, consumption still outruns production, and 1974 imports included 66,000 tons of feldspar from Scandinavia, Finland, Italy, France, and the Republic of South Africa.

Guatemala.—Cia. Vidrios, Soc. Anon. (CAVISA) extracted 33,000 tons of feldspar in 1974 for use in its own factory, the only glassmaking facility in the country, and in mid-1975 inaugurated a new and larger plant with a rated capacity of 40,000 tons of feldspar per year.

India.—The joint output of six large firms (Bharat Mineral Supply Corp., Golecha Palwat & Co., G. L. Kala, R. D. Maniar & Co., Shetty & Co., and Syed Altaf Hussain), all operating in the northwestern State of Rajasthan, amounted to approximately 70% of India's total 1975 feldspar production.

Italy.—Nearly three-quarters of Italy's total 1975 feldspar output came from quarries operated by C. Maffel & Co. at Pinzolo, Trento Province, near the southern border of the Dolomite Alps. Crude material from those sources was processed in the company's three mills (a primary crushing plant near the mine site, and grinding mills at Darzo and Trento) for use in ceramics, paint, and glass.

Norway.—Detailed discussions of Norway's feldspar and nepheline syenite industries were featured in a journal article.[2]

Sweden.—The only feldspar producer in Sweden, AB Forshammars Bergverk (sub-

[2] Industrial Minerals (London). Scandinavia: Norway's Industrial Minerals. No. 88, January 1975, pp. 19–41.

sidiary of Luossavaara Kiirunavaara AB, a Government-owned producer of iron ore) mines the Limberget pegmatite deposit in Orebro Province, about 25 miles north of Köping. It was announced that the ore body has been estimated to contain at least 0.7 million tons (already exposed) and 4 million tons (proved by drilling) of the type of material currently being exploited.[3]

Thailand.—It was reported that the Thai Mining Industry Co. of Bangkok (70% Thai-controlled, 30% British) will invest the equivalent of $1 million in a venture aimed at producing 44,000 tons per year of industrial minerals, including feldspar, within the national borders, thereby providing employment for about 125 additional mine workers and at the same time effecting a drastic reduction of the sums currently being spent to obtain those minerals from foreign sources.

United Kingdom.—Goonvean & Rostowrack China Clay Co., Ltd., has been the only remaining supplier of Cornish Stone (or China Stone) since 1973 when English Clays Lovering Pochin Co., Ltd., ceased producing that widely used feldspathic material. Recently Goonvean & Rostowrack reported that, despite ample reserves, their production of Cornish Stone has been hard put to keep abreast of expanding demand, largely because of difficulty in maintaining a sufficient force of specially trained workers for the exacting hand-selection process involved.[4]

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[3] Industrial Minerals (London). Feldspar and Nepheline Syenite—Rivals in a Flux. No. 100, January 1976, p. 17.

[4] Page 19 of work cited in footnote 3.

Table 5.—Feldspar: World production, by country

(Short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Mexico	107,042	204,262	158,521
United States	791,900	[r] 762,723	669,898
South America:			
Argentina	33,532	17,479	[e] 8,800
Brazil	[r] 99,848	107,246	[e] 110,000
Chile	584	3,093	421
Colombia	33,069	31,636	[e] 33,000
Guatemala	--	33,069	[e] 33,000
Peru	2,739	[r] [e] 2,800	[e] 2,800
Uruguay	226	1,937	1,939
Europe:			
Austria	2,260	--	--
Finland	64,285	70,082	75,593
France	[e] 245,000	265,414	[e] 265,000
Germany, West	392,192	413,194	[e] 416,000
Italy	208,692	262,149	204,158
Norway [2]	[r] 282,971	[e] 285,000	[e] 285,000
Poland [e]	33,000	33,000	33,000
Portugal	[r] 26,475	32,959	14,506
Spain [3]	71,650	79,693	[e] 83,000
Sweden	[r] 30,374	35,234	[e] 35,000
U.S.S.R. [e]	300,000	305,000	310,000
United Kingdom (china stone)	53,809	[e] 55,000	[e] 55,000
Yugoslavia	56,005	61,833	[e] 66,000
Africa:			
Egypt	3,343	2,456	--
Kenya	1,610	3,133	1,781
Malagasy Republic	[4] 63	[4] 11	753
Mozambique	915	926	[e] 950
Nigeria [e]	5,500	5,500	5,500
South Africa, Republic of	34,934	43,585	33,460
Zambia	13	1,959	[e] 2,200
Asia:			
Burma	343	728	[e] 770
Hong Kong	1,477	6,135	2,270
India	43,872	60,071	40,596
Japan [5]	[r] 53,713	68,718	43,494
Korea, Republic of	31,372	27,136	22,198
Pakistan	1,314	3,684	[e] 4,400
Philippines	27,556	11,293	4,307
Sri Lanka	689	859	859
Thailand	4,971	7,714	14,358
Oceania: Australia	[r] 3,091	3,473	[e] 3,500
Total	[r] 3,050,429	3,310,184	3,041,032

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, the People's Republic of China, Czechoslovakia, Romania, and the Territory of South-West Africa produce feldspar, but available information is inadequate to make reliable estimates of output levels.

[2] Described in source as lump feldspar; does not include nepheline syenite as follows in short tons: 1973—220,793; 1974—224,430; 1975—345,266.

[3] Includes pegmatite.

[4] Chiefly labradorite.

[5] In addition, the following quantities of aplite were produced in short tons: 1973—[r] 546,750; 1974—539,670; 1975—357,056.

TECHNOLOGY

Feldspar containing more than a minimal trace of iron is unsuitable for use in the manufacture of such specialized ceramics as porcelain insulators, hospital stoneware, and sanitary ware, but in most commercial deposits a large part of the feldspar occurs in intimate association with detrimental amounts of mica and garnet, both of which are iron-bearing minerals. Although these minerals are only weakly magnetic, it was found that high-intensity wet magnetic separation provided an adequate means of eliminating them from the ore stream, thus converting an otherwise troublesome waste material into a salable product.[5]

Bureau of Mines research in 1975 included a continuing study of the feasibility of producing feldspar and glass-sand concentrates by processing granite from various sources. It was reported that in three of four head samples from New Hampshire, it was difficult to effect liberation of the feldspar from accompanying iron minerals without grinding to a fineness beyond the limit imposed by glassmaking specifications. In related work, preliminary mineralogical and beneficiation studies were started on samples of a mixture of feldspar, quartz, biotite, and clay that constitutes the overburden at a granite quarrying operation in Georgia.

Another sector of Bureau of Mines research was directed toward finding environmentally attractive and economically advantageous outlets for waste glass, especially the material that could be made available by the systematic collection of discarded single-use beverage bottles. A report was issued presenting results obtained in one phase of this investigation.[6]

Computer control of the flow of the glassmaking materials, including feldspar and cullet (recycled glass), is a salient feature of the ultramodern batch house recently placed in service at the TV-tube plant of Owens-Illinois, Inc., in Columbus, Ohio. Details of this innovative facility, which incorporates a system for the electrostatic precipitation and collection of even the most finely divided solids from the furnace effluent and their return to the batch, were described in a journal article.[7]

In a study made in the Netherlands it was concluded that, according to time criteria, it is possible by proper choice of refining agents to achieve satisfactory melting performance with a soda-lime glass batch incorporating sand and potassium feldspar in particle-size ranges below 100 mesh.[8]

NEPHELINE SYENITE

Nepheline syenite is a light-colored rock that, although resembling medium-grained granite in texture, contains a significantly smaller proportion of quartz and consists principally of nepheline and alkali feldspars, usually in association with minor amounts of other minerals. Large quantities of nepheline syenite (after processing to remove objectionable substances, especially iron-bearing minerals) are consumed in making glass and ceramics. There is no domestic production of nepheline syenite in grades suitable for these purposes, however, and U.S. needs are wholly supplied by imports.

Customarily, U.S. consumption of feldspathic materials consists of roughly two-thirds feldspar plus aplite and one-third nepheline syenite from Canada, where Indusmin, Ltd., and Sobin Chemicals (Canada), Ltd., are the only two producers. In 1974, the last year for which an estimate is available, Canadian production totaled approximately 607,000 tons with a value of $8.5 million, increases from 1973 of 5% in tonnage and 15% in value, but the quantity exported to the United States in 1975 was sharply down from the corresponding figure for 1974, the first decrease recorded since 1961.

Other than Canada, only two countries are known to produce significant quantities of nepheline syenite—Norway with 221,000 tons in 1973 and 224,000 tons in 1974,

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[5] Ceramic Age. Magnetic Separation Yields Feldspar From Mill Tailings. V. 91, No. 1, January-February 1975, p. 6.

[6] Liles, K J., and M. E. Tyrrell. Waste Glass as a Raw Material for Lightweight Aggregate. BuMines IC 8104, 1976, 8 pp.

[7] Svec, J. J. New Batch Plant at O-I is Fully Automatic. Ceram. Ind., v. 105, No. 5, November 1975, pp. 12–14.

[8] Houben, M. M. H., H. W. Morelissen, and J. Cornelissen. Influence of Grain Size of Sand and Potassium Feldspar in Combination With Refining Agents on the Melting Properties of Soda-Lime Glass Batch. Pres. at 77th Ann. Meeting, Am. Ceram. Soc., Washington, D.C. May 3–8, 1975, Paper 38–G–75; abs. in Am. Ceram. Soc. Bull., v. 54, No. 4, April 1975, p. 432.

and the U.S.S.R. where, although production figures are not published, the material is reportedly used in glass and ceramics and also as a source of alumina for electrolytic aluminum plants.

The price range quoted for imported nepheline syenite in Ceramic Industry Magazine, January 1976, was from $13.00 to $31.45 per ton, depending upon grade, purity, grind, packaging, transportation, quantity sold, and other factors. Industrial Minerals (London), December 1975, quoted price ranges for Norwegian nepheline syenite, c.i.f. main European port, as follows:

Glass grade, 32 mesh (Tyler), bulk, per short ton	$36–$41
Ceramic grade, 325 mesh (Tyler), bagged, per short ton	54– 60

Prices for Canadian material were listed as "nominal."

The June 7, 1976, issue of American Paint & Coatings Journal quoted paint-grade nepheline syenite in 50-pound bags, carload lots, f.o.b. Ontario, at $34.35 to $47.85 per ton.

Table 6.—U.S. imports for consumption of nepheline syenite

Year	Crude		Ground	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	258	$4	473,838	$6,022
1974	4,605	79	505,028	7,558
1975	6,275	98	424,838	6,869

APLITE

Aplite is an aluminous silicate mineral material of granitic texture containing quartz mixed with varying proportions of soda or lime-soda feldspar; it is usually not suitable for use in ceramics but, if sufficiently low in iron, finds ready acceptance in the manufacture of glass, especially container glass. Japan, with about one-half million tons per year, is the world's foremost producer of aplite.

Aplite of glassmaking quality was produced in the United States in 1975 only from two open pit operations in central Virginia. The Feldspar Corp. mined aplite near Montpelier, Hanover County, and treated the material by wet grinding, classification, and gravity separation, followed by dewatering, drying, and high-intensity magnetic separation to eliminate iron minerals. Sobin Chemicals, Inc., an affiliate of International Minerals and Chemical Corp., operated an aplite mine near Piney River, Nelson County, and removed iron from the dry-ground ore by a high-intensity magnetic process.

Total U.S. production of aplite, which has been estimated at about 210,000 tons per year,[9] declined moderately in 1975.

Aplite prices are not commonly quoted in trade journals, but the product traditionally commands a somewhat lower per-ton price than feldspar. Prices of $15.25 per ton for low-iron material, f.o.b. producing point, and ranging downward to $11.50 per ton for grades higher in iron, were mentioned as current.[10]

[9] Rogers, C., Jr. Feldspar, Aplite, and Nepheline Syenite. Min. Eng., v. 28, No. 3, March 1976, pp. 34–35.

[10] Work cited in footnote 9.

Ferroalloys

By Thomas S. Jones [1]

Production and consumption of ferroalloys decreased with few exceptions in the United States in 1975 compared with 1974. Production, totaling less than 2 million tons, was the least since 1962, with several producers reporting operating rates of less than 50% of capacity. Consumption of most ferroalloys was at 70% to 80% of 1974 levels, paralleling decreases in business activity at steelplants and iron foundries, the major users of ferroalloys. Production and consumption of chromium alloys and consumption of ferronickel all fell to about half of 1974 amounts, in line with a similar decline in production of stainless steel. Ferromanganese production increased 6% upon reactivation of a blast furnace. The general climate that prevailed in the U.S. ferroalloy industry was experienced in foreign countries as well because of worldwide slackening of steel production.

In the United States, investment in new ferroalloy facilities was concentrated almost entirely in ferrosilicon plants. Increases in productive capacity scheduled by 1977 were expected to add over 200,000 annual tons. Additional significant new capacity for ferrosilicon was being added in Canada, as were new facilities for chromium alloys in Africa and for manganese alloys in Mexico, Brazil, and West Europe. U.S. steel producers showed increasing interest in participating in ferroalloy ventures, both domestic and foreign.

U.S. trade in ferroalloys was again strongly in deficit. The deficit in chromium alloys more than doubled, as did the amount of imported high-carbon ferrochromium. However, the deficit in silicon alloys dropped as imports decreased and exports increased, both substantially. Producers' and consumers' stocks increased for all major ferroalloys except that consumers' stocks of silicon alloys declined. Stock building was especially pronounced for chromium alloys. Price changes for domestic material were relatively insignificant. Increases and decreases both occurred by amounts generally much smaller than in 1974.

Technical developments in agglomeration and steelmaking, as well as political happenings in Africa, promised to accelerate the use of ferrochromium produced from South African ores. The consequence will be a shift of traditional preferences from alloys high in chromium to those of lower chromium content.

Detailed information concerning production, trade, and use of specific alloys can be found in the respective chapters on chromium, manganese, molybdenum, nickel, silicon, tungsten, and vanadium.

Legislation and Government Programs.—The U.S. Environmental Protection Agency (EPA) released a study done by Batelle Columbus Laboratories on product flexibility of ferroalloy furnaces. The agency found that sealed furnaces have the lowest air pollution potential, but very few furnaces in the United States are of this type. The study concluded that sealed furnaces have lower product flexibility than open furnaces and are particularly difficult to use for making high-silicon materials. A near-term shift by U.S. producers to sealed furnaces was judged unlikely.[2]

On February 24, EPA issued interim final water pollution regulations affecting producers of manganese and chromium. By July 1977 the average manganese ef-

[1] Physical scientist, Division of Ferrous Metals.
[2] Mobley, C. E., and A. O. Hoffman. A Study of Ferroalloy Furnace Product Flexibility. U.S. Environmental Protection Agency, EPA-650/2-75-063, July 1975, 52 pp.

fluent from an existing electrolytic manganese plant was not to exceed 1.356 pounds per thousand pounds of product, and chromium in effluent from an electrolytic chromium plant was not to average over 0.053. By July 1983 these amounts of effluent were to be reduced to 0.339 and 0.027, respectively. It was proposed that even tighter standards of 0.148 and 0.008, respectively, be adopted for new plants.[3]

Government stockholdings of ferroalloys are given in table 1.

Table 1.—Government inventory of ferroalloys (stockpile grade), December 31, 1975

(Thousand short tons)

Alloy	National stockpile	Supplemental stockpile	Total [1]
Ferrochromium:			
High-carbon	126	276	403
Low-carbon	128	191	319
Ferrochromium-silicon	26	33	58
Ferrocolumbium (contained columbium)	0.5	--	0.5
Ferromanganese:			
High-carbon	30	578	607
Medium-carbon	29	--	29
Ferromolybdenum (contained molybdenum)	.1	--	.1
Ferrotungsten (contained tungsten)	1	--	1
Silicomanganese	24	--	24

[1] Data may not add to totals shown because of independent rounding.

DOMESTIC PRODUCTION

Production and shipments of ferroalloys fell below the 2-million-ton level for the first time since 1962. Compared with 1974, production was off 16% and shipments were down by 25%. Producer operating rates of 50% of capacity were not unusual, with one firm reporting production at 30% of capacity for much of the year. The strongest showing relative to a year ago was in ferromanganese; production increased 6% as the United States Steel Corp. resumed blast furnace production of the alloy at its National Works in McKeesport, Pa. Ferroalloy categories showing the least production decreases were ferrophosphorus and "Other." In the "Other" category, outputs of ferronickel and spiegeleisen were essentially unchanged from 1974. Strength in production and shipments of these materials and of ferromanganese kept the overall decline in value of shipments to 3%. Production of chromium alloys, especially affected by the drop in stainless steel production, fell by nearly one-half. Union Carbide Corp. consolidated its Ferroalloys Div. and its Mining and Metals Div. into a single, new Metals Div. in the first half of the year.

Investment in new domestic facilities for producing tonnage ferroalloys was small except for silicon alloys. The Airco Alloys Division of Airco, Inc. (Airco) undertook rehabilitation of an existing 25 megavolt-ampere (MVA) ferrochromium-silicon furnace at Niagara Falls, N.Y. Allegheny Ludlum Steel Corp., a division of Allegheny Ludlum Industries, Inc. and a large consumer of chromium alloys, began looking for major sources of supply other than those originating in Southern Rhodesia. Allegheny Ludlum took a minority interest in a new ferrochromium plant to be built in the Republic of South Africa by Johannesburg Consolidated Investment Co. Ltd. (JCI). Late in the year, Satralloy, Inc. switched a ferrochromium furnace to production of high-carbon ferromanganese at its Steubenville, Ohio plant. This move from ferrochromium to ferromanganese foreshadows a similar switch by Union Carbide at its Marietta, Ohio plant, once a joint venture for charge chromium in South Africa begins producing by 1977. When new facilities become fully operational in 1976, the Chemetals Division of Diamond Shamrock Corp. reportedly will double its capacity for "massive manganese" to 17,000 annual tons at Kingwood, W. Va.

Domestic ferrosilicon capacity was scheduled to increase substantially by 1977, by over 200,000 annual tons, 50% basis. In addition to a first full year of production from a computer-controlled 60 megawatt (MW) furnace at Union Carbide's Ashtabula, Ohio plant, future ca-

[3] Federal Register. Ferroalloys Manufacturing Point Source Category. V. 40, No. 37, Feb. 24, 1975, pp. 8030–8041.

pacity was augmented by the yearend energizing of two new ferrosilicon furnaces. Foote Mineral Company started a 24 MW unit at its Graham, W. Va. plant, and Ohio Ferro-Alloys Corp. began bringing a 46 MVA furnace into production at its Philo, Ohio plant. Airco proceeded with installation at Niagara Falls of a 24 MW furnace which was to become operational in late 1976. By mid-1977 a 40 MW unit with a ferrosilicon capacity of 72,000 annual tons, 50% basis, was to start producing under the management of Tennessee Alloys Corp., a division of International Minerals & Chemical Corp. (IMC). This furnace is a joint venture between IMC and Allegheny Ludlum, and is to eventually replace present smelting facilities at Bridgeport, Ala.

In specialty ferroalloys, Duval Sierrita Corp. began production of ferromolybdenum in the first part of 1975. Duval's new plant near Tucson, Ariz. has an annual capacity of 3.5 million pounds of 60% to 64% ferromolybdenum, made by batchwise silicothermic reduction of roasted molybdenite concentrate. The Pesses Co. announced plans for producing a similar quantity of such heavy metal ferroalloys as ferromolybdenum beginning in 1976 in a plant being constructed at Pulaski, Pa. Purchased raw materials are to be processed into a variety of ferroalloys at the rate of 5 tons per day, initially using aluminothermic methods.

Table 2.—Ferroalloys produced and shipped from furnaces in the United States [1]

	1974 r				1975			
	Production		Shipments		Production		Shipments	
	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value (thousands)	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value (thousands)
Ferromanganese [2]	544,361	78	573,877	$162,082	575,809	79	556,131	$222,522
Silicomanganese	196,140	65	192,181	57,014	143,262	66	126,418	53,913
Ferrosilicon [3]	931,852	56	927,070	356,965	790,860	55	709,937	321,470
Chromium alloys:								
Ferrochromium:								
High-carbon	220,923	67	226,728	92,284	117,643	67	116,357	78,483
Low-carbon	87,263	72	93,111	71,096	53,973	70	43,325	56,489
Ferrochromium-silicon	98,974	36	100,652	50,935	51,992	37	41,306	27,527
Other alloys [4]	28,386	52	28,748	17,242	25,209	48	22,495	15,048
Total	435,546	60	449,239	231,557	248,817	59	223,483	177,547
Ferrophosphorus	106,486	20	133,185	9,061	102,896	21	96,006	10,927
Ferrocolumbium	1,174	65	1,279	7,899	615	65	481	3,549
Other [5]	67,942	--	68,710	111,617	64,195	--	55,639	116,809
Grand total	2,283,501	--	2,345,541	936,195	1,926,454	--	1,768,095	906,737

r Revised.
[1] Does not include alloys consumed in the making of other ferroalloys.
[2] Includes fused-salt electrolytic low carbon ferromanganese ("massive manganese").
[3] Includes silicon metal, silvery iron, and inoculant type alloys.
[4] Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.
[5] Includes ferroboron and other complex boron additive alloys, ferromolybdenum, ferronickel, ferrotitanium, ferrotungsten, ferrovanadium, ferrozirconium, spiegeleisen, and other miscellaneous alloys.

Table 3.—Producers of ferroalloys in the United States in 1975

Producer	Plant locations	Products [1]	Type of furnace
Airco, Inc., Airco Alloys Div	Calvert City, Ky; Charleston, S.C; Mobile, Ala; Niagara Falls, N.Y	FeCr, FeCrSi, FeMn, FeSi, SiMn.	Electric.
Alabama Alloy Co., Inc	Bessemer, Ala	FeSi	Do.
AMAX Inc., Climax Molybdenum Co. Div.	Langeloth, Pa	FeMo	Metallothermic.
Bethlehem Steel Corp	Johnstown, Pa	FeMn	Blast.

See footnotes at end of table.

Table 3.—Producers of ferroalloys in the United States in 1975—Continued

Producer	Plant locations	Products [1]	Type of furnace
Chromasco Ltd., Chromium Mining & Smelting Corp. Div.	Woodstock, Tenn	FeCr	Electric.
Diamond Shamrock Corp., Chemetals Div.	Kingwood, W. Va	FeMn	Fused salt electrolytic.
Englehard Minerals & Chemical Corp.:			
Minerals and Chemicals Div.	Strasburg, Va	FeV	Metallothermic.
Philipp Brothers Div. Roane Electric Furnace Co., Inc.	Rockwood, Tenn	FeMn, FeSi, SiMn.	Electric.
Foote Mineral Company, Ferroalloys Div.	Cambridge, Ohio; Graham, W. Va; Keokuk, Iowa	FeCrSi, FeSi, FeV, silvery pig iron, other.[2]	Do.
Gulf & Western Industries, Inc., New Jersey Zinc Co. Div.	Palmerton, Pa	Spln	Do.
Hanna Mining Co.:			
Hanna Nickel Smelting Co	Riddle, Oreg	FeNi, FeSi	Do.
Silicon Div	Wenatchee, Wash	FeSi, Si	Do.
Interlake Inc., Globe Metallurgical Div.	Beverly, Ohio; Selma, Ala	FeCr, FeCrSi, FeSi, Si, SiMn.	Do.
International Minerals & Chemical Corp., Industrial Minerals Div.:			
Tennessee Alloys Corp	Bridgeport, Ala	FeSi	Do.
Tennessee Metallurgical Corp.	Kimball, Tenn	FeSi	Do.
Kawecki Berylco Industries, Inc.:			
National Metallurgical Corp. Div.	Springfield, Oreg	Si	Do.
Penn Rare Metals Div	Revere, Pa	FeCb	Metallothermic.
Metallurg, Inc., Shieldalloy Corp.	Newfield, N.J	FeB, FeCb, FeTi, FeV, other.[2]	Do.
Molycorp, Inc	Washington, Pa	FeB, FeMo, FeW.	Metallothermic.
Ohio Ferro-Alloys Corp	Brilliant, Ohio; Philo, Ohio; Powhatan, Ohio	FeB, FeMn, FeSi, Si, SiMn.	Electric.
Pennzoil Company, Duval Sierrita Corp.	Sahuarita, Ariz	FeMo	Metallothermic.
Reactive Metals and Alloys Corp.	West Pittsburg, Pa	FeSi, FeTi, other.[2]	Electric.
Reading Alloys, Inc	Robesonia, Pa	FeCb, FeV	Metallothermic.
Reynolds Metals Company	Sheffield, Ala	Si	Electric.
Sandgate Corp., Tenn-Tex Alloy Corp. of Houston (leased to Union Carbide Corp.)	Houston, Tex	FeMn, SiMn	Do.
Satra Corp., Satralloy, Inc. Div.	Steubenville, Ohio	FeCr, FeCrSi, FeMn.	Do.
Union Carbide Corp., Metals Div.	Alloy, W. Va; Ashtabula, Ohio; Marietta, Ohio; Niagara Falls, N.Y; Portland, Oreg; Sheffield, Ala	FeB, FeCr, FeCrSi, FeMn, FeSi, FeV, FeW, Si, SiMn, other.[2]	Do.
United States Steel Corp	McKeesport, Pa	FeMn	Blast.
Ferrophosphorus:			
FMC Corporation, Mineral Products Div.	Pocatello, Idaho	FeP	Electric.
Mobil Oil Corp., Mobil Chemical Co. Div.	Nichols, Fla	FeP	Do.
Monsanto Company, (Monsanto Industrial Chemicals Co.)	Columbia, Tenn; Soda Springs, Idaho	FeP	Do.
Occidental Petroleum Corp., Hooker Chemical Div., Hooker Chemicals & Plastics Corp.	Columbia, Tenn	FeP	Do.
Stauffer Chemical Co., Industrial Chemical Div.	Mt. Pleasant, Tenn; Silver Bow, Mont; Tarpon Springs, Fla	FeP	Do.
Tennessee Valley Authority	Muscle Shoals, Ala	FeP	Do.

[1] FeMn, ferromanganese including spiegeleisen and manganese metal; SiMn, silicomanganese; FeMn, ferromanganese; FeMo, ferromolybdenum; FeNi, ferronickel; FeP, ferrophosphorus; FeSi, ferrosilicon; FeTi, ferrotitanium; FeV, ferrovanadium; FeW, ferrotungsten; Si, silicon metal; SiMn, silicomanganese; Spln, spiegeleisen.

[2] Includes specialty silicon alloys, zirconium alloys, and miscellaneous ferroalloys.

CONSUMPTION AND USES

As a result of production decreases of about 20% compared with 1974 in both the steel and iron castings industries, consumption of almost all ferroalloys declined in 1975. Ferrous applications, predominantly by steelplants, accounted for 80% to 90% of reported consumption for nearly all groups of ferroalloys. Among major ferroalloys, consumption of silicomanganese declined the least in the ferrous end use categories other than stainless steel, indicating that some steelplants and foundries preferred using silicomanganese rather than a combination of ferromanganese and ferrosilicon. Pronounced consumption decreases occurred for ferrochromium and ferronickel, as stainless steel production fell to about half that of 1974.

In specialty ferroalloys, demand for columbium, vanadium, and titanium alloys was aided by continued growth in production of high-strength low-alloy steels. Use of ferroboron in steel strongly increased, and greater amounts of ferrovanadium and ferronickel were used by iron foundries. Ferrotungsten usage was down substantially, at least partly because tungsten carbide is increasingly being favored for making cutting materials. Reported consumption for ferrophosphorus does not include the substantial amount consumed as feed material for vanadium production. A growing market for ferrophosphorus was as an extender in zinc-rich paints.

The format of the accompanying consumption tables has been rearranged to conform with the method of presentation used in the individual commodity chapters. Categories of data tabulated are the same as in prior years.

Table 4.—Consumption by end use of ferroalloys as additives in the United States in 1975 [1]

(Short tons of alloys)

End use	FeMn	SiMn	FeSi	FeTi	FeP	FeB
Steel:						
Carbon	688,241	97,285	141,651	804	9,890	326
Stainless and heat-resisting	10,617	5,808	18,793	1,117	29	18
Other alloy	174,568	37,472	76,656	838	1,298	377
Tool	2,046	15	2,261	W	--	--
Total steel [2]	875,472	140,580	239,361	2,759	11,217	721
Cast irons	24,582	12,033	346,801	96	4,351	13
Superalloys	628	W	424	585	--	W
Alloys (excluding alloy steels and superalloys)	14,432	3,788	53,452	1,548	201	57
Miscellaneous and unspecified	3,064	4,158	43,203	182	406	2
Total	918,178	160,559	683,241	5,170	16,175	793
Percent of 1974	79	91	e 75	70	79	200

e Estimate. W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."

[1] FeMn, ferromanganese including spiegeleisen and manganese metal; SiMn, silicomanganese; FeSi, ferrosilicon including silicon metal, silvery pig iron, and inoculant alloys; FeTi, ferrotitanium including such other forms as scrap titanium metal; FeP, ferrophosphorus including other phosphorus materials; FeB, ferroboron, including other boron materials.

[2] Except for data withheld and for unspecified included under "Miscellaneous and unspecified."

Table 5.—Consumption by end use of ferroalloys as alloying elements in the United States in 1975 [1]

(Short tons of contained elements)

End use	FeCr	FeMo	FeW	FeV	FeCb	FeNi
Steel:						
Carbon	3,743	232	--	813	400	--
Stainless and heat-resisting	119,038	666	43	20	198	17,255
Other alloy	53,041	1,175	34	3,344	728	6,662
Tool	2,547	301	283	413	6	--
Total steel [2]	178,369	2,374	360	4,590	1,332	23,917
Cast irons	6,462	1,562	2	53	--	509
Superalloys	8,585	151	39	20	180	186
Alloys (excluding alloy steels and superalloys)	4,637	413	52	29	19	708
Miscellaneous and unspecified	3,346	72	--	11	49	5
Total	201,399	4,572	453	4,703	1,580	25,325
Percent of 1974	56	78	45	77	72	55

[1] FeCr, ferrochromium including other chromium ferroalloys and chromium metal; FeMo, ferromolybdenum including calcium molybdate; FeW, ferrotungsten including melting base self-reducing tungsten; FeV, ferrovanadium including other vanadium-carbon-iron ferroalloys; FeCb, ferrocolumbium including small amount of ferrotantalum-columbium under "Miscellaneous and unspecified;" FeNi, ferronickel.

[2] Except for unspecified included under "Miscellaneous and unspecified."

Table 6.—Distribution of consumption by end use of ferroalloys in the United States in 1975[1]
(Percent)

End use	FeMn	SiMn	FeSi	FeTi	FeP	FeB	FeCr	FeMo	FeW	FeV	FeCb	FeNi
Steel:												
Carbon	75.0	60.6	20.7	15.6	61.2	41.1	1.9	5.1	--	17.3	25.3	--
Stainless and heat-resisting	1.1	3.6	2.8	21.6	.2	2.3	59.1	14.5	9.5	.4	12.5	68.2
Other alloy	19.0	23.3	11.2	16.2	8.0	47.5	26.3	25.7	7.5	71.1	46.1	26.3
Tool	.2	(2)	.3	W	--	--	1.3	6.6	62.5	8.8	.4	--
Total steel[3]	95.3	87.5	35.0	53.4	69.4	90.9	88.6	51.9	79.5	97.6	84.3	94.5
Cast irons	2.7	7.5	50.8	1.9	26.9	1.6	3.2	34.2	.4	1.1	--	2.0
Superalloys	.1	W	.1	11.3	--	W	4.3	3.3	8.6	.4	11.4	.7
Alloys (excluding alloy steels and superalloys)	1.6	2.4	7.8	29.9	1.2	7.2	2.3	9.0	11.5	.6	1.2	2.8
Miscellaneous and unspecified	.3	2.6	6.3	3.5	2.5	.3	1.6	1.6	--	.3	3.1	(2)
Total	100	100	100	100	100	100	100	100	100	100	100	100

W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."
[1] Based on gross weight of alloy for additive alloys (table 4); on contained weight for alloying elements (table 5).
[2] Less than 0.05.
[3] Except for data withheld and for unspecified included under "Miscellaneous and unspecified."

STOCKS

Producers' stocks of chromium, manganese, and silicon alloys all rose substantially with those of chromium and silicon alloys regaining 1970–72 levels. Stocks of chromium alloys more than tripled; stock rebuilding for manganese alloys corresponded to an inventory increase of about 60% and for silicon alloys more than twice that amount. Consumers' stocks of manganese and chromium alloys advanced further to new record levels. Stocks of silicon alloys decreased by about one-half, as stocks of 75% and 50% grades declined nearly steadily throughout the year.

Table 7.—Stocks of ferroalloys held by producers and consumers in the United States at yearend
(Short tons)

	Producer		Consumer	
	1974 (gross weight)	1975 (gross weight)	1974 (gross weight)	1975 (gross weight)
Manganese ferroalloys [1]	84,873	136,929	293,048	324,046
Silicon alloys [2]	57,495	132,702	184,075	93,501
Ferrochromium [3]	20,512	74,387	53,747	67,820
Ferrotitanium [4]	W	W	2,911	2,043
Ferrophosphorus [5]	26,431	39,763	6,385	4,174
Ferroboron	61	561	205	218
Total	189,372	384,342	540,371	491,802
	1974 (contained element)	1975 (contained element)	1974 (contained element)	1975 (contained element)
Ferromolybdenum [6]	W	878	1,190	708
Ferronickel	W	W	r 11,511	11,267
Ferrotungsten	W	W	245	116
Ferrovanadium	304	542	1,732	868
Ferrocolumbium	463	549	860	551
Total	767	1,969	15,538	13,510

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes ferromanganese, silicomanganese, and manganese metal for 1975; includes spiegeleisen also for 1974.
[2] Includes ferrosilicon, silvery iron, silicon metal, and miscellaneous silicon alloys.
[3] Includes other chromium ferroalloys and chromium metal.
[4] Includes other titanium materials.
[5] Includes other phosphorus materials.
[6] Includes calcium molybdate.

PRICES

Little activity occurred in producers' list prices for ferroalloys. For the most part, poor market conditions offset cost pressures such as those from rising rates for electrical power. Although U.S. producers mostly adhered to listed prices, competition for sales below listed prices was reported, especially in chromium alloys. Discounts were more common for imported alloys, which in some cases began the year selling at a premium but ended below domestic prices. Producer prices decreased by less than 10% for some manganese, silicon, and tungsten alloys, whereas prices increased in September by about the same magnitude for ferromolybdenum and ferronickel. In October, the spot low-alloy ferrocolumbium price rose to about 20% greater than that 12 months previous. Ferrovanadium prices did not change in 1975. Representative producer prices are given in the following tabulation:

Alloy	Price in 1975 [1]	
	Beginning	Yearend
Charge chromium (66% to 70%)	$0.48 –$0.57	$0.50
Low-carbon ferrochromium, 0.05% maximum carbon	.83 – 1.20	.92 –$1.20
Standard 78% ferromanganese, dollars per long ton of alloy	440	440
Low-carbon ferromanganese, 0.1% maximum carbon	.595	.545
Ferromolybdenum, powder	3.19	3.50
Ferronickel	1.97	2.16
Ferrosilicon, 50%	.335	.325
Ferrosilicon, 75%	.385	.365

[1] Per pound contained, except as noted otherwise.

Source: Metals Week.

FOREIGN TRADE

The United States was again a net importer of all major kinds of ferroalloys. Compared with 1974, the value deficit increased by about one-third to over $400 million, whereas the volume deficit dropped slightly to about 800,000 tons. The deficit in chromium alloys more than doubled in value while that for silicon alloys decreased by over one-half in both value and volume.

Although exports of ferroalloys were more than twice those in 1974, value increased only 56% because average unit value decreased 25%. Increases in unit value for many ferroalloys were more than offset by decreases in exports of high value ferroalloys and in the unit value for ferrosilicon. Ferrosilicon exports increased sixfold to become the most important ferroalloy export item, amounting to 41% of volume and 27% of value. Ferromanganese exports were about 4.6 times as great as in 1974 at little change in unit value. Canada received more of the chief ferroalloy export categories than any other country, taking over half of total ferroalloy exports and an especially high percentage of ferromanganese. Sweden and West Germany were the next largest recipients overall. Ferroalloys were exported worldwide to over 40 countries.

Value of ferroalloy imports increased one-third over that for 1974, although import volume decreased by 1%. Value rose because of substantial increases in unit value for many ferroalloys, the increases exceeding 85% for chromium alloys and 50% for all grades of ferromanganese. Unit value of 8% to 60% ferrosilicon imports nearly tripled, partly because of a higher proportion of the 50% grade, causing average silicon content in this class to rise from 30% to 40%. The rate of importation was greatest in the first half of 1975.

Volume of ferroalloy imports declined relative to a year ago for practically every category with the major exception of ferrochromium, imports of which were virtually as great as reported consumption. Average chromium content in imported high-carbon ferrochromium dropped an additional 2.5% to 65.2%. Imports of high-carbon ferrochromium more than doubled and were more than twice domestic production. Imports of low-carbon ferrochromium were higher by about one-third and also exceeded domestic production. Early in the year, the Department of the Treasury was petitioned concerning alleged subsidies to the Republic of South Africa ferrochromium producers by their Government. Responsive action was subsequently taken in South Africa, so that by yearend the Department of the Treasury found that no bounties or grants were being paid.

Of the other large-tonnage ferroalloys, imports of high-carbon ferromanganese decreased by only 4% while those of other manganese alloys were about 80% of 1974 amounts. Ferromanganese imports corresponded to about two-thirds of domestic production and somewhat less than half of reported consumption. Imports of silicon alloys were less significant, decreasing from 1974 levels about one-half overall to an amount about 10% that of both production and reported consumption. Ferronickel imports decreased by over one-third, but remained the major source of U.S. supply.

The main group of ferroalloys, consisting of ferrochromium, ferrochromium-silicon, ferromanganese, silicomanganese, and ferrosilicons with 8% to 60% and 60% to 80% silicon, and ferronickel, grew collectively to 98% of volume and 94% of value of imports. Within this group, manganese and chromium alloys accounted for 85% of volume with the balance being about equally divided between ferrosilicon and ferronickel. High-carbon ferromanganese and high-carbon ferrochromium were imported in the largest quantity, together amounting to two-thirds of the total. In descending order, for manganese alloys the main sources were France, the Republic of South Africa, and Japan; for chromium alloys, the Republic of South Africa, Rhodesia, and Japan; and for silicon alloys, Norway, Canada, and Japan. About two-thirds of imported ferronickel was from New Caledonia, with practically all the rest coming from the Dominican Republic. However, value of ferronickel imports was nearly equally divided between the two sources.

Imports were received from 32 countries, about one-third of the total each coming from Western Europe, Africa plus the Middle East, and Asia plus Oceania. Countries in the Western Hemisphere provided 7% of the total. The leading supplying countries were Japan ($125 million and 191,000 tons), the Republic of South Africa ($83 million and 235,000 tons), and France ($54 million and 148,000 tons). The leader in value of shipments to the United States for chromium alloys was Japan, while France led for manganese alloys.

Table 8.—U.S. exports of ferroalloys

Alloy	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Ferrocerium and alloys	55	$286	96	$503	50	$300
Ferrochromium	15,164	5,091	7,245	r 3,765	13,218	9,075
Ferromanganese	8,574	2,137	7,011	2,204	32,487	10,743
Ferromolybdenum	1,112	3,151	2,047	7,094	1,121	4,798
Ferrophosphorus	19,030	773	3,677	408	437	57
Ferrosilicon	15,984	4,051	6,575	3,338	39,712	15,732
Ferrotungsten	6	50	10	215	17	137
Ferrovanadium	1,416	8,734	1,335	7,863	1,018	7,952
Ferroalloys, n.e.c	22,328	9,485	18,172	12,186	8,970	9,886
Spiegeleisen	1,063	103	547	80	335	208
Total	84,732	33,861	46,715	r 37,656	97,365	58,888

r Revised.

Table 9.—U.S. imports for consumption of ferroalloys and ferroalloy metals

Alloy	1974 r			1975		
	Gross weight (short tons)	Content (short tons)	Value (thousands)	Gross weight (short tons)	Content (short tons)	Value (thousands)
Chromium alloys:						
Ferrochromium containing 3% or more carbon	116,158	71,319	$33,134	257,567	158,055	$135,041
Ferrochromium containing less than 3% carbon	46,527	31,502	22,790	61,242	39,933	55,589
Ferrosilicon-chromium	7,553	(1)	2,045	4,136	(1)	2,041
Total chromium alloys	170,238	XX	57,969	322,945	XX	192,671
Manganese alloys:						
Ferromanganese containing less than 1% carbon	4,165	3,493	1,660	2,786	2,355	2,496
Ferromanganese containing over 1% and less than 4% carbon	42,829	34,803	15,467	34,195	27,893	19,841
Ferromanganese containing 4% or more carbon	374,228	289,578	71,299	360,231	276,402	106,044
Ferrosilicon-manganese (Mn content)	67,751	44,720	20,632	54,723	35,156	22,989
Total manganese alloys	488,973	372,594	109,058	451,935	341,806	151,370

See footnotes at end of table.

Table 9.—U.S. imports for consumption of ferroalloys and ferroalloy metals—Continued

Alloy	1974 r Gross weight (short tons)	1974 r Content (short tons)	1974 r Value (thousands)	1975 Gross weight (short tons)	1975 Content (short tons)	1975 Value (thousands)
Ferrosilicon:						
8% to 60% silicon	28,762	8,480	$6,269	15,329	6,182	$9,010
60% to 80% silicon	112,556	83,616	59,305	54,026	40,265	32,000
80% to 90% silicon	289	243	165	825	682	764
Over 90% silicon	842	792	762	257	236	176
Total ferrosilicon	142,449	93,131	66,501	70,437	47,365	41,950
Ferronickel	102,430	33,425	87,255	65,046	20,699	67,818
Other ferroalloys:						
Ferrocerium and other cerium alloys	29	(1)	238	17	(1)	187
Ferromolybdenum	41	29	140	2	2	10
Ferrophosphorus	--	--	--	1	(1)	2
Ferrotitanium and ferrosilicon titanium	2,296	(1)	3,122	536	(1)	1,125
Ferrotungsten and ferrosilicon tungsten	505	404	3,029	256	209	2,542
Ferrovanadium	223	144	1,142	179	137	1,435
Ferrozirconium	850	(1)	575	548	(1)	416
Ferroalloys n.e.c.[2]	2,490	(1)	7,417	1,745	(1)	6,433
Total other ferroalloys	6,434	XX	15,663	3,284	XX	12,150
Metals:						
Chromium	1,960	(1)	5,388	1,629	(1)	6,630
Manganese	2,506	(1)	1,379	4,378	(1)	4,041
Silicon (less than 99.7% silicon)	5,508	5,422	5,809	3,710	3,654	2,705
Base metal alloys[3]	16,577	(1)	12,341	3,980	(1)	3,531
Total	937,075	XX	361,363	927,344	XX	482,866

r Revised. XX Not applicable.
1 Not recorded.
2 Principally ferrocolumbium.
3 Principally silicon metal, commercial purity.

WORLD REVIEW

Statistics on world production of ferroalloys are summarized in table 10. Installations of new facilities from which significant amounts of additional production were expected to be available by 1977 included those for chromium alloys in the Republic of South Africa and Turkey, for manganese alloys in Brazil, Mexico, and Portugal, and for silicon alloys in Canada. Metal Bulletin published another world survey of ferroalloy producers, its previous survey appearing in 1971.[4]

Brazil.—A total of 279,000 tons of ferroalloys was produced, of which the main items were, in thousands of tons, ferrochromium, 58; ferromanganese, 96; silicomanganese, 43; and ferrosilicon, 60. Expansion plans, favored by abundant hydropower and present favorable pollution regulations, suggested a doubling of ferroalloy production by 1980, including alloys produced by the thermite process. Such expansion reportedly would leave Brazil with 40% of capacity available for export, even after satisfying projected strong growth of internal consumption. Ferrochromium led 1975 exports, accounting for about half of a record 63,000 tons.

Manganese.—By shortly into 1976, Eletrosiderurgia Brasileira S.A. (SIBRA) was to bring into operation three new 24-MVA furnaces, two for ferromanganese and one for silicomanganese. These Japanese-designed furnaces are closed, automated, and have pollution controls. SIBRA was reportedly planning installation of two larger furnaces for production in 1978–79.

Silicon.—Expansions adding to ferrosilicon production by 1976–77 were projected by Cia. Brasileira Carbureto de Calcio (CBCC), Cia. Paulista de Ferro-Ligas, Eletrometalur S.A., and Ligas de Alumínio S.A.; CBCC and Eletrometalur were planning to make further capacity increases in 1978–80.

4 Metal Bulletin (London). Ferro-Alloys Survey—1975, ed. by J. H. Parry. 1975, 158 pp.

Canada.—*Manganese.*—Union Carbide Canada Limited lost most of the first half year's production from a 100,000-ton-per-year ferromanganese furnace owing to an extended strike at its Beauharnois plant in Quebec.

Silicon.—Also at Beauharnois, late in the year Chromasco Ltd. started a new 24 MW furnace with capacity to produce 30,000 annual tons of 50% ferrosilicon. SKW Electro-Metallurgy Canada Ltd. (SKW-Canada) began construction at Becancour, Quebec of a new ferrosilicon and silicon metal plant. The plant was scheduled to begin producing about 60,000 annual tons about equally divided between ferrosilicon and metal in 1976.

Greece.—Soc. Minière et Métallurgique de Larymna S.A. (Larco) began implementing an expansion program that would keep Larco as Europe's largest ferronickel producer. Larco's output of 27% ferronickel has been running at 16,000 annual tons of contained nickel. The first stage of expansion at Larymna would increase this by 10,000 annual tons of contained nickel at a cost of $75 million.

Iceland.—Icelandic Alloys Ltd. was formed jointly between the Government of Iceland and Union Carbide Corp. to build a coastal plant near Reykjavik for producing about 50,000 annual tons of 75% ferrosilicon by 1977–78. Total investment capital of about $70 million was to be furnished, 55% by the Government and 45% by Union Carbide.

Japan.—With an overall production of 2,358,000 tons of ferroalloys, Japan's output fell only 6% below its 1974 total and again exceeded that of the United States. Chief items produced were, in thousands of tons; ferrochromium, 536; ferromanganese, 716; silicomanganese, 480; ferrosilicon, 361; and ferronickel, 221. In addition, 8,365 tons of heavy metal ferroalloys were produced. Additions to ferrosilicon capacity included a 40 MVA furnace rated at 30,000 annual tons started by Ube Denki Kaguku late in the year, and a 25 MVA furnace for the 75% alloy to begin operation in 1976 by Kureha Seitetsu Co., a subsidiary of Pacific Metals Co., Ltd. Pacific Metals was also trying to attract joint owners for a new ferronickel smelter in Niigata Prefecture. The project was to begin in 1976 with an initial target of 18,000 annual tons, to be increased ultimately to 44,000 tons.

Korea, Republic of.—The output of three small producers, Inchon Ferro-Alloy Co., Korean Electrometallurgy, and Sam Chok Industries Co. Ltd., was concentrated on ferrosilicon, mostly the 75% grade, and totaled 23,500 tons. Inchon Ferro-Alloy, a joint venture between two Japanese firms and Inchon Iron & Steel Co., the state steel company, started a new 28 MVA ferrosilicon furnace in midyear.

Mexico.—Cia. Minera Autlan S.A. de C.V. was building a $30 million plant for high-carbon ferromanganese with a capacity of 66 MVA at Tamos, Veracruz. Completion of the first and second phases was scheduled for the first half of 1976.

Philippines.—Maria Cristina Chemical Industries started production of ferrosilicon on Mindanao and, with Japanese interests, formed Mindanao Alloy Corp., to be a new producer of ferrosilicon. The new company projected an annual capacity of 30,000 tons by late 1977 from two 25 MVA furnaces. Electro Alloys Corp., owned 40% by Japanese interests and the balance by Philippine Laurel Co., began building a ferrosilicon furnace, also on Mindanao. The furnace was scheduled for completion in 1976 to give a capacity of 12,400 annual tons.

Portugal.—A high-carbon ferromanganese plant rated at 100,000 annual tons was brought into production by Eurominas Electrometalurgica SARL (Eurominas) at Setúbal, a coastal site on the Bay of Setúbal southeast of Lisbon. French interests, including Pechiney Ugine Kuhlmann, own a majority of Eurominas.

South Africa, Republic of.—Total production of ferroalloys amounted to 825,000 tons.

Chromium.—A number of expansion programs have raised fears of overproduction. The expansions, based on lower grade South African ores, are expected to modify longstanding materials preferences in stainless steelmaking. Tubatse Ferrochrome (Pty.) Ltd., a joint venture held 49% by Union Carbide, began construction at Steelpoort of a charge chromium plant rated at 120,000 annual tons. Some production was expected by the end of 1976 and full production in 1977, all for export. A similar size new plant for charge chromium was expected by JCI, also to begin producing in 1977. Allegheny Ludlum Steel took a minority interest in the plant, construction of which was receiving technical assistance from Japan's Showa Denko K.K. Feralloys Ltd. was expanding production facilities at Machadodorp, with completion scheduled for 1977 also.

Manganese.—The expansion program of Feralloys included additional manganese alloy furnaces at Cato Ridge, to begin operating in 1977. Transalloys (Pty.) Ltd. was also planning for 1977 operation a 25 MVA silicomanganese furnace rated at 37,000 annual tons.

Spain.—With a combined 1975 production of nearly 314,000 tons of ferroalloys, Spanish firms were adding capacity for chromium, manganese, and silicon alloys. Ferroaleaciones Españolas S.A., a subsidiary of a firm in which privately-owned Cargill Inc. took a majority interest in 1975, was expanding ferrochromium production 50% to about 30,000 annual tons. Most of the increased output may be domestically consumed by a growing stainless steel industry. Ferroaleaciones y Electrometales was adding fully enclosed 30 MVA silicomanganese and 20 MVA ferromanganese furnaces built by Japan's Tanabe Kakoki at Boo, Santander. At Monzon, Huesca, Hidro Nitro Española S.A. was projecting production in 1976 from a second 45 MVA ferrosilicon furnace rated at 30,000 annual tons, 75% grade.

Turkey.—State-owned Etibank was expanding its processing of ore into ferroalloy with a 50,000-ton-per-year plant for high-carbon ferrochromium near Elazig. Two 17 MVA furnaces built by Japan Metals & Chemicals Co. Ltd. were expected to begin producing in 1976 using hydropower and a feed of about equal amounts of lumpy ore and concentrates.

U.S.S.R.—Negotiations continued with U.S., Japanese, and West European firms on large ferroalloy projects to produce 320,000 tons of ferrochromium and 1.2 million tons of ferromanganese annually. The ferromanganese plant would be part of a manganese complex at Nikopol, near Krivoi Rog in the Ukraine.

Venezuela.—Delays developed in two ferrosilicon projects now expected to ultimately add 100,000 annual tons of production by 1978. As a result, first production was expected in 1976 from a joint project between the Government and Japan's Sumitomo Shoji Kaisha, and in 1977 from the Venbozel project, a joint project between France's Nobel Bozel S.A. and the Venezuelan Corp. of Guyana.

Yugoslavia.—Ferroalloy production totaled 216,000 tons, about two-thirds of which was estimated to be silicon alloys with the remainder about equally divided between high-carbon ferrochromium and ferromanganese. Expansions were slated for ferrosilicon and ferronickel. State-owned Tovarna Dusika Ruse planned a 24 MVA unit for production of 75% ferrosilicon beginning in 1977. Smelter production from the Feni ferronickel project was projected to begin in 1979 and was expected to sustain a level of 16,000 tons of contained nickel over more than a 20-year period.

Table 10.—Ferroalloys: World production, by country and furnace type
(Thousand short tons)

Country [1] and furnace type	1973	1974	1975 [p]
BLAST FURNACE [2]			
Europe:			
Czechoslovakia	30	37	[e] 40
France	600	588	475
Germany, West [3]	405	483	341
Hungary	20	79	101
Italy	72	83	[e] 65
Poland	142	147	[e] 150
Portugal	1	--	--
U.S.S.R	1,098	1,093	[e] 1,140
United Kingdom	176	100	92
Africa: South Africa, Republic of	64	45	[e] 65
Asia:			
Korea, Republic of [4]	29	38	23
Thailand [4]	--	9	1

See footnotes at end of table.

Table 10.—Ferroalloys: World production, by country and furnace type—Continued

(Thousand short tons)

Country [1] and furnace type	1973	1974	1975 p
ELECTRIC FURNACE [5]			
North America:			
Canada [2]	221	273	176
Mexico	90	89	95
United States [2]	2,520	2,284	1,926
South America:			
Argentina	48	54	e 55
Brazil	188	238	279
Chile	12	16	15
Colombia	--	(6)	(6)
Peru	--	1	1
Uruguay	(6)	(6)	(6)
Venezuela	1	2	2
Europe:			
Austria	r 7	7	e 7
Belgium	122	144	112
Bulgaria	49	50	e 55
Czechoslovakia	134	140	139
Finland	44	53	44
France	r 490	495	437
Germany, West	292	312	283
Hungary	11	12	e 14
Italy	191	191	199
Norway	r 829	964	961
Poland	172	173	174
Portugal	r 10	12	e 11
Spain [7]	265	293	314
Sweden	249	236	e 230
Switzerland e	23	23	23
Yugoslavia	170	209	216
Africa:			
Egypt	4	e 4	5
South Africa, Republic of	r 547	653	e 760
Asia:			
India	195	212	192
Japan	2,243	2,499	2,358
Taiwan	15	30	26
Turkey e	10	10	10
Oceania: Australia [2] [8]	84	84	62
Total	r 11,873	12,465	11,674

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, the People's Republic of China and North Korea are known to produce ferroalloys, but output of these materials are included in estimates for pig iron in the iron and steel chapter, therefore they have been omitted here to avoid duplication. East Germany also is known to produce ferroalloys but it is not clear from source publications whether output has been included together with that of pig iron in the iron and steel chapter. Also Greece, Luxembourg and Southern Rhodesia may produce ferroalloys and output, if any, is also included with pig iron in the iron and steel chapter.

[2] Blast furnace ferroalloys production by Australia, Belgium, Canada, and the United States included under electric furnace output.

[3] Blast furnace ferromanganese, ferrosilicon and spiegeleisen only; other blast furnace ferroalloys are included with pig iron production in the iron and steel chapter.

[4] Includes electric furnace ferroalloys, if any, are produced.

[5] In addition to the countries listed, the United Kingdom and the U.S.S.R. are known to have produced electric furnace ferroalloys and Romania may have produced some electric furnace ferroalloys, but output is not reported and no basis for estimation is available.

[6] Less than ½ unit.

[7] May include small quantities of blast furnace ferroalloys, if any are produced.

[8] Year ended November 30 of year stated.

TECHNOLOGY

The Bureau of Mines continued laboratory study of its process for conserving chromium and nickel through recovery of recyclable alloy pigs from stainless steelmaking dusts. Dusts with additions of coke breeze were pelletized, after which the pellets were dried and then smelted in an inductively heated graphite crucible using a ferrosilicon scavenger to maximize recovery. Resultant pigs contained 10% to 20% chromium, 6% to 12% nickel, about 4.5% carbon, 1% or more silicon, and were essentially free of zinc, lead, and sulfur. Zinc and lead volatilized in the process were recovered as byproduct oxide fume.[5]

[5] Powell, H. E., W. M. Dressel, and R. L. Crosby. Converting Stainless Steel Furnace Flue Dusts and Wastes to a Recyclable Alloy. BuMines RI 8039, 1975, 24 pp.

Advances in agglomeration and steelmaking can be expected to enhance use of South African grades of chromite, which contain less chromium and tend to be more friable than those from Rhodesia. In one of several processes being developed for agglomerating fine chromite, waste silica dust from ferroalloy operations is being used as a binder. This application was made by adoption of the "COBO" process at the Trollhättan, Sweden plant of Ferrolegeringar AB, a subsidiary of Metallurg, Inc. In this plant, ground chromite fines with additions of about 3% each of hydrated lime and silica dust were balled and then steam-hardened in autoclaves at 16 atmospheres and 205° C. Operations started in 1975, and by midyear pellets were being produced at the rate of 20 tons per hour, thus making simultaneous use of two types of fines which otherwise detracted from manufacturing economics.[6] Another plant for utilizing chromite fines, in this case through bonding with 3% molasses and 2% to 3% hydrated lime, was scheduled to go into operation in West Germany early in 1976. Mineralhandels Gesellschaft Bouteiller, now owned by Ruhrkohle A.G., projected an output of 40,000 tons per year of 40x40x20 millimeter pellets from a plant located at the Duisburg Harbor, near the Netherlands border. Also, a soft briquetting technique was announced from the Republic of South Africa, to be tested on Transvaal chromite. From a steelmaking standpoint, favorable signs that chromium feed materials produced by agglomeration could be successfully used were given by Japanese producers, who have indicated development of methods for efficiently using ferrochromium containing less than 60% chromium.

Japanese steelmakers also described use of molten ferrochromium in stainless steelmaking at an international ferroalloys conference held in Brazil in June under joint sponsorship of the Instituto Latinoamericano del Fierro y el Acero (ILAFA) and the Associação Brasileira dos Produtores de Ferro-ligas (ABRAFE). The practice described was that of the Nippon Steel Corp. for using desulfurized molten ferrochromium as part of the hot metal charge to an oxygen steelmaking furnace. A double blow was used with the second blow under reduced pressure. This integration of ferroalloy production with steelmaking was claimed to reduce energy requirements, increase efficiency, and lower costs.[7]

In the United States, new ferrophosphorus and rare earth containing ferrosilicon additives were developed. One of these was a briquette composed of a mixture of crushed ferrophosphorus and fertilizer-grade monocalcium phosphate, the phosphate serving both as a binder and, upon dissolution of the briquette in molten steel, as an oxidant of excess silicon in the ferrophosphorus. This briquette was devised to alleviate shortages of low-silicon ferrophosphorus. Commercial use began following successful testing as a ladle additive in open hearth production of free machining steels.[8] A larger variety of rare earth containing ferrosilicons became available, also, and the new forms were being tested in steelplants under production conditions. Techniques of usage and alloy formulation were still under development.[9]

According to a review of air and water pollution control in ferroalloy production, basic control technology has changed little in recent years but the practical experience gained has resulted in refinements. Cost of emission control within the industry has ranged from 4% to 15% of sales. For control of airborne emissions, pressure-type baghouses are being used in the majority of plants as the chief collection device. Utilization of fume has been confined to fumes high in silica or to recycling of silicomanganese furnace fumes when their manganese content is sufficiently great.[10]

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[6] Doughty, F. T. C. Operation of a New Pelletizing Process. Iron and Steel International, v. 48, No. 6, December 1975, pp. 443–445, 447.

[7] Metal Bulletin Monthly. Ilafa's Ferro-Alloy Fiesta. No. 59, November 1975, pp. 17–19.

[8] Mills, N. T., and H. M. Stevens. A New Form of Steelmaking Ferrophos to Overcome Limited Supplies. Pres. at AIME Annual Meeting, New York, Feb. 10, 1975, Paper B75–2, 16 pp.

[9] Cannon, J. G. Rare Earths—Supply Ample in 1975. Eng. Min. J., v. 177, No. 3, March 1976, pp. 187–188.

[10] Person, R. A. Current Status of Ferroalloys Emission Control. Presented at AIME Elec. Furnace Conf., Houston, Tex., Dec. 10, 1975, 21 pp.

Fluorspar

By Richard H. Singleton [1] and John E. Shelton [2]

As the world's largest consumer of fluorspar, the United States continued to rely on imports for about 84% of its reported fluorspar demand in 1975; 76% of these imports came from Mexico, and Spain supplied 12%. Domestic shipments of finished fluorspar decreased 30% from that of 1974 to 140,000 tons; 41% of this was acid-spar. Reported consumption declined 18% because of decreased use in the steel industry and decreased manufacture of hydrofluoric acid (HF) for the chemical industry. Consumers' inventories decreased 26% to 320,000 tons. No sales were made from U.S. Government inventories, which remained at 1.3 million tons. During 1975, U.S. imports of fluorspar, two-thirds as acid-spar, decreased 21% to 1,050,000 tons. Imports of synthetic and natural cryolite increased 4% to 22,000 tons, and imports of 70% HF increased 42% to 46,000 tons.

Price increases ranging from 12% to 25% were reported for various grades of fluorspar. All increases were predominantly the result of inflationary cost increases; there was no shortage throughout the world, and no cartel was known to be controlling prices.

The Trade Act of 1974 authorized the President of the United States to enter into trade agreements with foreign countries, whereby the import duty on fluorspar could be eliminated or reduced 60%. By yearend 1975, no changes in tariff had been noted.

U.S. Borax and Chemical Co. continued evaluation of its fluorspar-barite deposit in the Sweetwater district southwest of Knoxville, Tenn.

Consumption of met-spar by the iron and steel industry remained at 44% of the U.S. total for both 1974 and 1975. Consumption of acid-spar to make HF for the chemical and aluminum industries remained the major use for fluorspar, consuming 54% of the total in both 1974 and 1975.

Concern about the escape of chlorofluorocarbons from aerosol sprays and refrigerants into the atmosphere continued. Demand for fluorine for manufacturing chlorofluorocarbons was down resulting in a reduction in demand for acid-spar.

World production decreased 5% to about 5.09 million tons, approximately 50% of which was acid-spar. Mexico remained the largest producer with 23% of world production followed by the U.S.S.R. The U.S.S.R. remained the second largest consumer, using about 1.0 million tons in 1975. Numerous mine closings in Thailand lowered its world production ranking from third to seventh.

The largest fluorspar importing countries were the United States, the U.S.S.R., Japan, West Germany, and Canada.

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[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Supervisory physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient fluorspar statistics [1]

	1971	1972	1973	1974	1975
United States:					
Production:					
Mine production ---- short tons --	815,046	710,668	561,149	447,253	376,601
Material beneficiated ------ do ----	758,169	771,411	663,361	409,005	401,477
Material recovered -------- do ----	247,250	245,047	232,891	207,816	132,060
Finished (shipments) ----- do ----	272,071	250,347	248,601	201,116	139,913
Value f.o.b. mine - thousands --	$17,263	$17,315	$17,381	$14,297	$10,888
Exports ---------------- short tons --	12,491	2,764	2,428	5,847	1,355
Value --------------- thousands --	$525	$184	$171	$316	$194
Imports for consumption - short tons --	1,072,405	1,181,533	1,212,347	1,336,389	1,050,448
Value f.o.b. foreign port thousands --	$34,530	$47,851	$52,620	$60,988	$61,059
Consumption (reported) - short tons --	1,344,742	1,352,149	1,351,705	1,524,532	1,244,938
Consumption (apparent)[2] ----- do ----	1,314,972	1,487,933	1,508,759	1,428,719	1,300,096
Stocks Dec. 31:					
Domestic mines:					
Crude ---------------- do ----	165,610	111,565	57,901	44,196	57,833
Finished -------------- do ----	28,259	15,295	8,675	13,668	11,386
Consumer ---------------- do ----	436,759	377,942	327,703	430,642	319,552
World: Production -------------- do ----	5,243,644	4,992,406	r 5,214,659	r 5,337,018	5,093,768

r Revised.
[1] Does not include fluosilicic acid and imports of hydrofluoric acid and cryolite.
[2] Apparent consumption includes finished shipments, plus imports, minus exports, and plus or minus consumer inventory adjustments.

Legislation and Government Programs.—The U.S. Office of Preparedness established a stockpile objective of 159,000 tons of met-spar and prepared a plan to dispose of 253,000 tons of excess met-spar and its entire inventory of acid-spar, 890,000 tons. By yearend 1975, Congress had not authorized disposal of these excess materials.

The Trade Act of 1974, which was signed in December, authorized the President under Title 1, for a period of 5 years, to negotiate trade agreements whereby the import duty on acid-grade fluorspar may be eliminated and on metallurgical-grade could be reduced 60%. Under Title 5, Generalized System of Preferences, the President was authorized to suspend the import duty on fluorspar for the most-favored less-developed countries; but after hearings were held, fluorspar was eliminated from the list of eligible minerals under this act.

U.S. fluorspar import duties effective through 1975 were as follows:

Item	Number	Rate of duty Long ton	Rate of duty Short ton	Statutory rate long ton
Acid grade (+97% CaF_2) --	522.21	$2.10	$1.875	$5.60
Metallurgical grade (−97% CaF_2) ----------	522.24	8.40	7.50	8.40

The Government, through the Office of Minerals Exploration, can grant loans up to 50% of approved costs for exploration of eligible deposits of fluorspar, but in 1975 the administrating agency, the U.S. Geological Survey, had no funds for this program.

Fluorspar was subject to a Federal depletion allowance of 22% on domestic production and 14% on foreign production.

The Bureau of Mines Metallurgy Research Center, Albany, Oreg., continued its research on fluorine recovery from phosphate rock. Synthetic fluorspar prepared from recovered fluosilicic acid was being tested in pilot plant basic oxygen furnace operations.

DOMESTIC PRODUCTION

During 1975, domestic shipments of fluorspar decreased 30% to 140,000 tons. About 41% was acid-spar and 59% was met-spar, which included gravel-spar, ceramic-spar and briquets. About 71% of production was in Hardin County, Ill. The rest was shipped from mines in Utah, Texas, Montana, Nevada, Kentucky, and New Mexico, in order of volume.

During 1975, 15 mines and 8 flotation and heavy-media plants operated, but only 4 plants operated full time. Names and locations of these facilities were as follows:

U.S. fluorspar-producing mines [1] and mills in 1975

State	Company	Mines	Plants
Colorado	Ozark-Mahoning Co	Cowdrey [2]	Flotation.
Illinois	Hastie Mining Co	Spar Mountain	None.
Do	Allied Chemical Corp	3 mines	2 flotation.
Do	Ozark-Mahoning Co	4 mines	Flotation. 2 heavy-media.
Do	Tamora Mining Co	1 mine	None.
Kentucky	Cerro Spar Corp	Babb-Barnes	Flotation.
Montana	Roberts Mining Co	Crystal Mountain [2]	Heavy-media.
Nevada	J. Irving Crowell, Jr. & Sons	Daisy	None.
Do	Spor Brothers	Mary	Do.
Texas	D & F Minerals Co	Paisano	Do.
Utah	U.S. Energy Corp	Fluoride Queen	Do.
Do	Willden Fluorspar Co	Lost Sheep	Do.
Do	Spor Brothers	Fluoride [2]	Do.
Total		15	[3] 8

[1] Mines having significant output in 1975.
[2] Output from inventory only.
[3] Four operations were full time.

Two mines were closed during the year, one in New Mexico, and the other in Kentucky. In March 1975, the Fluorspar Division of Allied Chemical Corp. purchased and took over control of Minerva Oil Co.'s fluorspar operations in Illinois and Kentucky.

In Kentucky, Cerro Spar Corp. operated the Babb-Barnes mine. This mining operation was a joint venture, which was owned 70% by Cerro Spar Corp., a wholly owned subsidiary of Cerro Corp., and 30% by Frontier Resources Inc., Denver, Colo., and J. Fred Landers, Nashville, Tenn. Also, in Kentucky, Allied Chemical Corp. closed the Lafayette mine and allowed it to flood.

In Texas, mining operations were continued by D & F Minerals Co. in the Christmas Mountains located on the north edge of Big Bend National Park. In Utah, Willden Fluorspar Co., the Spor Brothers, and U.S. Energy Corp. continued small shipments. In Nevada, J. Irving Crowell, Jr. & Sons, and Spor Brothers, near Beatty, Nev., continued shipments, Crowell to a steel company and Spor Brothers to a cement company. Bailey Fluorspar Co. continued to operate its buying stations at Marathon, Tex., and Delta, Utah, where it purchased washed and screened custom ore for the met-spar market.

In Illinois, both Ozark-Mahoning Co. (subsidiary of Pennwalt Corp.) and Allied Chemical Corp. carried on a continuous exploration and development drilling program. By so doing, they have been able to develop sufficient reserves to replace reserves depleted by production. The mines and operating plants of Ozark-Mahoning near Rosiclare, Ill., were closed by a labor dispute from July 1 to September 22.

U.S. Borax and Chemical Co., a subsidiary of Rio Tinto-Zinc Corp., Ltd., continued exploration drilling on its fluorspar-barite prospect in the Sweetwater district, southwest of Knoxville, Tenn. The company has announced major discoveries in McMinn, Monroe, and Loudon Counties that could total 50 million tons of fluorspar ore assaying 15% to 30% CaF_2. Allied Chemical Corp. completed drilling projects on the Brown's Canyon Claims near Salida, Colo., and abandoned all exploration activity in New Mexico.

Seven fluorspar briquetting or pelletizing plants operated during 1975. These plants furnished fluxing material for the iron and steel industry and cannot be classified either as producers or end use consumers of fluorspar; they were beneficiators or convertors of fluorspar ore into a more usable product. The compaction blends, containing fines, gravel, or filter cake, assayed from 35% to 97% CaF_2; additions of lime, limestone, and oxides of manganese, iron, aluminum, titanium, boron, etc., as well as cinders, were made to fulfill customer requirements. The briquetting industry operated at about one-half of capacity during 1975 and produced 224,000 tons of briquets valued at approximately $18 million. Operating data for 1975 were as follows:

	Tons	Average CaF_2 content
Total capacity	460,000	--
Fluorspar processed, all kinds	185,000	84%
Fluorspar briquets produced	224,418	61%
Fluorspar briquets shipped	216,955	61%

Locations of fluorspar briquetting plants operating in 1975 were as follows:

State	City	Company
Illinois	Rosiclare	Ozark-Mahoning Co.
Indiana	East Chicago	National Briquet Corp.
Michigan	Dearborn	Mercier Corp.
Pennsylvania	Duquesne	Cametco, Inc.
Texas	Brownsville	Delhi Foundry Sand Co.
		Ogleby Norton and Co.
		Ozark-Mahoning Co.

The fluorspar supply picture is incomplete without including the supply of fluorine derived from byproduct hydrofluosilicic acid (H_2SiF_6), which is recovered from the wet-process production of phosphoric acid. During 1975, 60,500 tons of H_2SiF_6 was recovered at phosphoric acid plants. Theoretically, the 79% fluorine content of this acid is equivalent to about 80,000 tons of acid-spar that would have been used to make HF for the chemical and aluminum industries and for fluoridation of public water supplies. About 67% of the H_2SiF_6 was used to make fluoride salts for the aluminum electroflux potlines, 12% was used for other chemical products, and 21% was used in water fluoridation. The H_2SiF_6 supply is expected to continue to increase slowly as new phosphoric acid plants are built in Florida and North Carolina.

Table 2.—Shipments of finished fluorspar, by State

State	1974			1975		
	Quantity (short tons)	Value: Total[1] (thousands)	Value: Average per ton	Quantity (short tons)	Value: Total[1] (thousands)	Value: Average per ton
Illinois	151,898	$12,247	$80.63	99,898	$8,957	$89.66
Utah	2,967	98	33.03	9,542	389	40.77
Other States[2]	46,251	1,952	42.20	30,473	1,542	50.61
Total and average	201,116	14,297	71.09	139,913	10,888	77.82

[1] F.o.b. mine.
[2] New Mexico, Montana, Kentucky, Nevada and Texas, 1974–75.

Table 3.—Shipments and mine stocks of finished fluorspar by grade, in the United States

Grade	1974				1975			
	Short tons	Value[1] (thousands)	Value per ton	Stocks[2] (short tons)	Short tons	Value[1] (thousands)	Value per ton	Stocks[2] (short tons)
Acid	77,093	$6,134	$79.57	4,112	56,944	$4,823	$84.70	5,461
Metallurgical	124,023	8,163	65.82	9,556	82,969	6,065	73.10	5,925
Total and average	201,116	14,297	71.09	13,668	139,913	10,888	77.82	11,386

[1] Fo.b. mine.
[2] As of Dec. 31.

CONSUMPTION AND USES

U.S. consumption as reported by consumers decreased 18% from 1,525,000 tons in 1974 to 1,245,000 tons in 1975; however, apparent consumption indicated a 9% decrease to 1,300,000 tons in 1975. As previously mentioned, the briquetting industry reported processing 185,000 tons of primary fluorspar averaging 84% CaF_2 and shipping about 217,000 tons of briquets averaging 61% CaF_2.

The major consuming industries were iron and steel, 44%; chemical, 40%; and aluminum, 14%. The other 2% was used to make glass, ceramics, enamels, calcium cyanamide, welding rods, cement, uranium tetrafluoride, magnesium metal, and nonferrous metal fluxes. Demand increased in the cement industry and in refining of certain nonferrous metals.

During 1975, the steel industry consumed about 550,000 tons of fluorspar of which 65% was used in basic oxygen furnaces, 16% in open hearth furnaces, 13% in electric furnaces, and the remainder in manufacturing iron and steel castings. Usage ranged from 3 to 11 pounds of fluorspar per ton of steel ingot and averaged about 9 pounds. Fluorspar substitutes that have been tried either require at least 50% more of the substitute material than fluorspar to perform the same fluxing and cleaning actions or contain deleterious elements that limit their use to specialty steels or certain types of furnaces. Substitute materials, such as colemanite, bauxite, ilmenite, olivine, limonite, and red mud or mixtures of them, were being used to start a furnace batch or to mix with fluorspar to make briquets.

During 1975, the U.S. aluminum industry produced 3,879,000 tons of aluminum ingot. At an assumed consumption rate of 55 pounds of fluorine per ton of aluminum, the calculated total industry consumption was 226,000 tons of acid-spar equivalent. This acid-spar was used to make HF, which in turn was used to make aluminum fluoride and sodium aluminum fluoride that were used to form the molten electrolyte in aluminum potlines. A small amount of acid-spar was added directly to aluminum and magnesium reduction cells during operation, as shown in table 4.

H_2SiF_6, recovered as a byproduct from the phosphoric acid industry, was an additional source of fluorine for making aluminum-cell electrolyte. Quantities of H_2SiF_6, equivalent of 49,000 tons of acid-spar, were used by the aluminum industry, thereby decreasing the total acid-spar consumed by the aluminum industry to about 177,000 tons.

During 1975, about 674,000 tons of acid-spar, domestic and foreign, was used to make HF in nine plants in the United States. Most of the plants were located at coastal ports in Texas, Louisiana, New Jersey, and Delaware. All, including the inland plants, were accessible by water routes.[3] In addition, 46,000 tons of HF was imported for consumption.

Inorganic fluorides were manufactured from HF for use as insecticides, preservatives, antiseptics, catalysts, fluxes, in fire extinguishers, and for steel pickling. Elemental fluorine gas, which is derived from HF, was used to manufacture uranium hexafluoride from tetrafluoride to produce sulfur hexafluoride, halogen fluorides, and emulsified perfluorochemicals. Organic fluorides were the volume leaders in the fluorine chemicals industry using over 50% of the HF produced. Organic fluorides were manufactured by reacting anhydrous HF with chloroform or carbon tetrachloride to produce a variety of chlorofluorocarbons. As chemically stable compounds, they performed outstandingly as refrigerants, aerosol propellants, solvents, resins, and elastomers. Chlorofluorocarbons, commonly called fluorocarbons, used as aerosol propellants were the subject of a growing controversy as to whether they affect the ozone layer in the stratosphere. The hypothesis proposes that ultraviolet radiation releases chlorine from the fluorocarbon and the chlorine reduces the density of the ozone layer, which shields the earth from the cancer-forming ultraviolet radiation. This possibility became the subject of a Government-sponsored study.

By early 1975, sales of fluorocarbon aerosols were down, and fluoride orders by chemical manufacturers were held up. The depressed market for fluorocarbons continued through 1975. It was estimated that it may be years before a scientific solution or explanation will be widely accepted and that, in the meantime, up to 15% of the acid-spar market could be affected.

Fluorine consumption in the manufacture of uranium for generating nuclear

[3] Chemical Marketing Reporter. Chemical Profile. V. 208, No. 20, Nov. 17, 1975, p. 9.

power had been estimated in 1974 using newly available information. In 1975, acid-spar demand for treatment of 14,500 tons of uranium oxide (U_3O_8) was estimated at 20,000 tons. Approximately 1.25 tons of acid-spar was required per ton of U_3O_8 used to make uranium hexafluoride, UF_6, from which fissionable U_{235} isotope was subsequently separated by gaseous diffusion. Since the gaseous diffusion plants went into operation, UF_6, depleted of most of the U_{235}, has been stockpiled. The U.S. Energy Research and Development Administration (ERDA) has reported that it has in stock about 170,000 tons of UF_6 and about 65,000 tons of UF_4. These materials contain about 70,000 tons of fluorine equivalent to about 152,000 tons of acid-spar. This large stockpile, plus possible decreased fluorine consumption per nuclear-energy unit, beclouds long-range predictions of large future fluorspar demands in fabrication of nuclear fuels.

Table 4.—Reported domestic consumption of fluorspar by end use and grade in 1975
(Short tons)

End use or product	Containing more than 97% calcium fluoride	Containing not more than 97% calcium fluoride	Total
Hydrofluoric acid [1]	673,626	--	673,626
Glass and fiberglass	5,185	4,087	9,272
Enamel and pottery	(2)	1,968	1,968
Welding-rod coatings	735	(2)	735
Primary aluminum and magnesium	737	--	737
Other nonferrous metal	--	(2)	(2)
Iron and steel castings	(3)	29,965	29,965
Open hearth furnaces	--	89,311	89,311
Basic oxygen furnaces	--	358,301	358,301
Electric furnaces	1,703	70,315	72,018
Other uses or products [4]	729	8,276	9,005
Total	682,715	562,223	1,244,938
Stocks, Dec. 31, 1975	50,200	269,352	319,552
Stocks, Dec. 31, 1974	128,282	302,360	430,642

[1] About 26% of this HF was used to manufacture fluoride salts for aluminum reduction cells.
[2] Included with "Other uses or products."
[3] Included with "Containing not more than 97% calcium fluoride."
[4] Includes fluorspar used to make ferroalloys and other furnace products.

Table 5.—Fluorspar (domestic and foreign) consumed in the United States, by State
(Short tons)

State	1975
Alabama, Kentucky, Tennessee	80,208
Arizona, Colorado, Utah	25,802
Arkansas, Kansas, Louisiana, Missouri	245,545
California	28,490
Connecticut, Massachusetts, New York, Rhode Island	28,306
Illinois	46,525
Indiana	56,991
Michigan	44,866
New Jersey	92,787
Ohio	162,061
Pennsylvania	129,890
Texas	225,369
West Virginia	49,374
Other States [1]	28,724
Total	1,244,938

[1] Includes Georgia, Maryland, North Carolina, Delaware, Iowa, Oklahoma, and Washington.

STOCKS

U.S. producers reported a 17% decrease to 11,400 tons of finished fluorspar in inventory. Domestic consumer stocks decreased 26% to 320,000 tons. No sales were made in 1975 by the General Services Administration from government stockpiles, which remained at 1,302,000 tons, as follows:

	Goal	Inventory	Authorized for disposal
Acid grade	--	890,000	890,000
Metallurgical grade	159,000	412,000	253,000
Total	159,000	1,302,000	1,143,000

Inventories in the major producing market-economy countries increased during the year.

PRICES

Domestic fluorspar prices, f.o.b. Illinois, as reported in the Engineering and Mining Journal, increased during the last three quarters of the year. The base price of dry acid-spar increased 11% to $95 per ton, and 70% effective CaF_2 met-spar pellets or briquets increased 19% to $83 per ton. According to the journal, acid-spar imported through Wilmington, Del., was quoted at $102.50 to $125 per ton.

The world price of fluorspar was strongly influenced by Mexican producers because they supplied nearly one-half of the fluorspar sold on the open market. Fluorspar prices at the Rio Grande Mexican border increased about 25%. Prices quoted in the Engineering and Mining Journal for 70% effective CaF_2 met-spar at the border for rail shipment f.o.b. cars rose from $48.50 per ton in December 1974 to $60.50 to $61 at yearend 1975; the price at Tampico, Mex., f.o.b. vessel, rose from $50 in 1974 to $63 during the same period.

Table 6.—U.S. prices of fluorspar

	1974	1975
Domestic f.o.b. Illinois-Kentucky:		
Acid-spar, dry basis, 97% CaF_2:		
Carloads	$85.50–$103.00	$95.00–$115.00
Bags, extra	9.00	9.00
Pellets, 90% effective CaF_2 (briquets)	85.00	--
Pellets, 70% effective CaF_2 (briquets)	70.00	83.00– 88.00
Ceramic-grade concentrate, 95% to 96% CaF_2	83.50– 96.00	95.00– 106.00
European: F.o.b. Wilmington/Philadelphia: Acid-spar, duty paid, dry basis	102.50	102.50– 125.00
Mexican: F.o.b. Mexico: [1]		
Met-spar, 70% effective CaF_2:		
Border, all rail, f.o.b. cars	48.50	60.50– 61.00
Tampico, Mex., f.o.b. vessel	50.00	63.00
Acid-spar, wet-filter-cake, 97% CaF_2: Eagle Pass, Tex., bulk	60.00– 62.00	73.50– 74.00

[1] U.S. import duty, insurance, and freight not included.

Source: December issues of Engineering and Mining Journal, 1974 and 1975.

FOREIGN TRADE

U.S. imports of fluorspar decreased 21% to 1,050,448 tons equaling 81% of apparent consumption. Mexico continued to supply most of these imports, accounting for 76% of volume in 1975, with European countries supplying most of the remainder. Approximately 67% of U.S. imports were acid-spar, which decreased 17% to 699,400 tons; the balance, mostly met-spar, was imported mainly from Mexico and decreased 29% in volume. An increasing amount of this met-spar was used to make briquets for use as a flux in steel furnaces. A small quantity, approximately 1,400 tons of fluorspar, was exported, primarily to Canada. In addition to fluorspar, 46,000 tons of 70% HF was imported, mainly from Canada, a 42% increase over that of 1974; and 22,000 tons of synthetic and natural cryolite was imported from 12 different countries.

Table 7.—U.S. exports of fluorspar

Year and country	Quantity (short tons)	Value
1972	2,764	$183,620
1973	2,428	171,255
1974	5,847	315,855
1975: [1]		
Canada	1,175	171,324
Dominican Republic	78	10,722
Germany, West	9	1,182
Japan	12	1,584
Malaysia	([2])	824
Mexico	50	3,063
Peru	11	1,980
South Africa, Republic of	20	3,604
Total	1,355	194,283

[1] Adjusted by the Bureau of Mines, Division of Nonmetallic Minerals.
[2] Less than ½ unit.

Table 8.—U.S. imports for consumption of fluorspar, by country and customs district

Country and customs district	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
CONTAINING MORE THAN 97% CALCIUM FLUORIDE				
Brazil: Philadelphia	--	--	10,676	$739
Canada: Galveston	642	$25	--	--
France: Philadelphia	--	--	6,842	532
Italy:				
Galveston	39,838	2,630	27,016	1,977
New Orleans	--	--	7,798	582
Total	39,838	2,630	34,814	2,559
Japan: Philadelphia	5,031	317	--	--
Kenya: Detroit	--	--	11,618	604
Mexico:				
El Paso	111,438	5,573	92,154	5,021
Galveston	6,639	403	--	--
Honolulu	231	13	--	--
Houston	3,248	173	--	--
Laredo	455,264	23,120	354,250	23,669
New Orleans	15,756	1,016	--	--
Philadelphia	10,843	568	13,238	712
Total	603,419	30,866	459,642	29,402
Morocco:				
Galveston	5,457	353	--	--
Philadelphia	--	--	5,824	474
Total	5,457	353	5,824	474
Mozambique: New Orleans	20,636	1,152	--	--
South Africa, Republic of:				
Detroit	--	--	10,364	682
New Orleans	3,035	158	8,337	527
Total	3,035	158	18,701	1,209
Spain:				
Cleveland	44,004	2,746	44,262	3,582
Galveston	--	--	6,394	403
Philadelphia	111,647	6,668	75,821	4,913
Total	155,651	9,414	126,477	8,898
Thailand: New Orleans	--	--	17,543	856
Tunisia: New Orleans	9,311	499	7,282	457
Grand total	843,020	45,414	699,419	45,730
CONTAINING NOT MORE THAN 97% CALCIUM FLUORIDE				
Canada:				
Buffalo	--	--	11,830	650
Detroit	--	--	5,009	390
Total	--	--	16,839	1,040
Mexico:				
Baltimore	45,202	1,815	15,641	915
Buffalo	19,741	899	9,486	532
Cleveland	9,373	474	10,054	499
Detroit	43	3	9,930	492
El Paso	17,516	464	20,568	654
Laredo	358,871	10,102	253,616	10,347
New Orleans	2,846	108	8,611	542
Philadelphia	7,148	364	6,172	305
St. Albans	--	--	56	2
San Francisco	--	--	56	1
Total	460,740	14,229	334,190	14,289
Spain:				
Detroit	29,289	1,180	--	--
Philadelphia	3,340	165	--	--
Total	32,629	1,345	--	--
United Kingdom: El Paso	--	--	(1)	(1)
Grand total	493,369	15,574	351,029	15,329

[1] Less than ½ unit.

Table 9.—U.S. imports for consumption of 70% hydrofluoric acid

Country	1973		1974		1975	
	Quantity (short tons)	Value	Quantity (short tons)	Value	Quantity (short tons)	Value
Canada	30,196	$9,295,461	30,595	$11,342,004	31,895	$13,950,150
Germany, West	(1)	897	--	--	(1)	825
Israel	--	--	--	--	(1)	1,350
Japan	--	--	--	--	227	93,953
Mexico	1,467	527,110	1,903	738,277	13,786	6,142,220
United Kingdom	--	--	--	--	331	148,494
Total	31,663	9,823,468	32,498	12,080,281	46,239	20,336,992

1 Less than ½ unit.

Table 10.—U.S. imports for consumption of cryolite [1]

Year and country	Quantity (short tons)	Value (thousands)
1972	25,642	$3,541
1973	19,789	5,052
1974	19,896	6,689
1975:		
Canada	1,420	638
China, People's Republic of	5,255	1,916
Czechoslovakia	523	223
Denmark	2,196	1,005
France	1,725	871
Germany, West	823	447
Hungary	438	199
Italy	1,246	584
Japan	7,061	2,597
Switzerland	(2)	1
Taiwan	1,102	417
Yugoslavia	331	160
Total	22,120	9,058

1 Only the material from Denmark is natural cryolite. All other is manufactured synthetic cryolite.
2 Less than ½ unit.

WORLD REVIEW

World production of fluorspar decreased 5% to about 5.09 million tons, approximately 50% as met-spar. Mexico remained the largest producer with 23% of world production, followed by, in order of volume, the U.S.S.R., Spain, the People's Republic of China,. and France. Numerous mine closings in Thailand lowered its world production ranking from third to seventh.

The United States remained the world's largest importer and consumer of fluorspar, importing 1.05 million tons in 1975. The U.S.S.R. was the world's second largest importer and consumer followed by Japan and West Germany.

North American fluorspar production decreased 12% to 1.41 million tons in 1975; inventory accumulation was more than 200,000 tons mainly because of reduced Mexican exports to the United States.

Western European production decreased 4% to 1.40 million tons in 1975 because of depressed market conditions; about 30% of this production was met-spar. Sizable stockpiles were accumulated during the year. The major producers were, in order of volume, Spain, France, Italy, the United Kingdom, and West Germany. Sweden continued to produce about 4,000 tons per year.

Eastern European, including Mongolian, production increased about 8% to an estimated 1.08 million tons, about two-thirds was met-spar.

Asian, excluding Mongolian, fluorspar production decreased 15% to about 723,-000 tons because of mine closings in Thailand caused by decreased Japanese demand and Thai political instability. Met-spar comprised approximately 90% of Asian production.

African fluorspar production increased 15% to an estimated 375,000 tons, because of increased output in Kenya and particularly in Morocco; about one-quarter was met-spar.

South American fluorspar production increased 7% to 134,000 tons, about three-quarters of which was met-spar. The increase was due to increased output in Brazil.

Brazil.—As the largest producer in South America, annual Brazilian output of fluorspar concentrate increased in 1975 to 71,-700 tons, approximately one-quarter of which was acid-spar. The industry operated at nearly full capacity. About one-third of the total production was exported, mainly as acid-spar. The United States received most of this export although about 6,000 tons went to Japan. The remainder of production was used mainly in the Brazilian steel industry. The ore was generally of high grade and easily minable. It was concentrated by flotation at a number of small plants. Exploration for new deposits continued in 1975 because reserves appeared to be sufficient for only about 10 years.

Canada.—Canada's only fluorspar mines, operated by Alcan's Newfoundland Fluorspar Works, were closed in June by a labor strike. Consequently, Canadian production all heavy-medium concentrate containing 65% CaF_2 fell from 175,000 tons in 1974 to 70,000 tons in 1975. Fluorspar imports, mostly acid-spar, increased 10% to 173,000 tons. More than one-half (54%) of imports continued to come from Mexico. Imports from Spain increased more than tenfold in 1975 to approximately 47,000 tons.

China, People's Republic of.—China continued to export about two-thirds of its substantial production of met-spar, estimated at approximately 385,000 tons in 1975. Imports of Chinese fluorspar by Japan decreased 41% in 1975 to 116,000 tons, and imports from China by the U.S.S.R. decreased 35% to 61,000 tons. The Tao-Ling mine and plant in Hunan Province continued to be the largest fluorspar producer in China.

France.—Fluorspar production decreased 13% to 378,000 tons, about one-half of which was acid-spar. Ore assays continued to drop, reaching an average of 45% CaF_2 in 1975. Exports, 67% to West Germany and the remainder to Western Europe and Canada, decreased 25% to 121,-000 tons; most of this exported product was met-spar. Imports nearly quadrupled to about 18,000 tons, mainly because of shipments of acid-spar from Morocco that began in 1975.

Italy.—Fluorspar production decreased 7% to 255,000 tons about 90% of which was acid-spar. Exports, more than 90% acid-spar, increased 12% to 93,000 tons, mainly to the United States and West Germany. Exports to the United States decreased 25% to about 30,000 tons. Exports to the U.S.S.R., about 12,000 tons, were begun in 1975. A total of about 40,000 tons, 78% met-spar, was imported mainly from Mexico and France. Italy had large stockpiles of fluorspar at yearend. Chimica de Fluoro Sardo SpA, closed its operation at Santa Lucia, Sardinia; capacity was about 20,000 tons of acid-spar. Soricom SpA, a consortium of Southland Mining of Australia and Associates, was developing the Piansiano fluorspar deposit north of Rome. They were unable to produce acid-spar, but planned an annual output of 110,000 tons of briquets by late 1978.

Kenya.—Fluorspar production in Kenya increased 42% to 60,000 tons in 1975 as a result of commissioning a flotation plant, by the Fluorspar Co. of Kenya, which went onstream in March. Reported annual capacity of this plant was 165,000 tons of acid-spar and 88,000 tons of met-spar. The company was 51% owned by the Government with the balance held in equal proportions by Bamburi Cement Co. and International Minerals & Chemical Corp. Exports to the United States began with the first shipment from this company in July and totaled about 12,000 tons in 1975. Shipments to Japan decreased 36% to about 17,000 tons. No shipments were made to the U.S.S.R. in 1975 or in 1974.

Mexico.—Mexican fluorspar production decreased 2% in 1975 to 1.20 million tons, 60% of which was acid-spar, and Mexico maintained its leadership with 23% of world production. It was evident that production could be increased readily because installed capacity was near 1.31 million tons and several expansion or development projects were in progress or being considered.

Among the expansion or development projects was the addition of new flotation units at operations of Compañía Minera Las Cuevas, doubling its acid-spar capacity to 100,000 tons per year. A similar expansion was underway at the Industrias Peñoles–Allied Chemical consortium mill at Compañía Minera Rio Colorado, where 180,000 tons annual capacity was to be added by 1976 to the existing 300,000-ton capacity. A new 77,000-ton-per-year flotation mill was brought onstream at the Minera San Fransisco del Oro facility. A cave-in at the small open pit Fluoros de Hidalgo mine reduced production by 50%. The mine was subsequently closed permanently. At Parral, Chihuahua, output of acid-spar was reduced pending full production at the HF plant of Quimica Fluor S.A. at Matamoros, Tamaulipas.

This new HF plant, located across the Rio Grande River from Brownsville, Tex., went onstream in June but was still in a trial period at yearend although reportedly on fulltime operation. Planned capacity of this modern plant was approximately 80,000 tons per year of 70% HF, and was expected to increase fourfold Mexico's internal consumption of acid-spar. Exports of 70% HF to the United States increased sevenfold to about 14,000 tons.

During 1975, it was reported that the Mexican Government made some effort to organize the marketing of fluorspar including setting a minimum price; those ideas were shelved because of strong industry resistance. The newly formed Mexican Fluoride Institute, which reportedly was instrumental in preventing those government actions, acquired a permanent staff and a full-time director general. Industry had a majority of delegates in this institute although the Government also was represented.

Exports of fluorspar decreased 22% in 1975 to 931,000 tons, 89% of which went to the United States. Exports of acid-spar and met-spar to the United States decreased 24% and 27%, respectively, to 460,000 tons and 334,000 tons. Approximately 67% of all U.S. deliveries[4] of fluorspar originated in Mexico during 1975 compared with 69% in 1974. Exports to Canada remained at 118,000 tons. Exports to Italy decreased 26% to 19,000 tons. Plans to further diversify the Mexican export market were indicated.

Apparent inventory buildup was approximately 200,000 tons based on production and export data and allowing for a domestic consumption of 60,000 tons.

Mongolia.—Mongolia continued as a significant world producer of fluorspar with an estimated 1975 production of 334,000 tons, all of which was exported to the U.S.S.R. It was announced that the capacity of Behrin mine would be doubled.

Morocco.—The new mine and flotation mill operated by Samine at El Hamman

[4] Deliveries equal U.S. imports + domestic shipments per table 1.

near Khemisset, 50 miles east of Rabat, completed its first full year of operation. This more than doubled Moroccan production to 52,000 tons in 1975.

Spain.—Total fluorspar production in 1975 increased 3% to 411,000 tons; about two-thirds was acid-spar. Minerals y Productos Derivados S.A., one of the two major producers, announced plans to build a flotation mill at Cucana in northern Spain; however, the depressed market prevented any action during 1975. Total exports, mainly to the United States and West Germany, decreased 12% to 247,000 tons. Exports to the United States decreased 17% to 156,000 tons. Large producers' inventories had accumulated by yearend, and price cutting occurred. Expected production was down for 1976.

Thailand.—Approximately one-half of the fluorspar mines in Thailand closed in 1975 because of lowered overseas demand, particularly in Japan, and because of instability, both real and suspected, in government mining policy. Total 1975 production decreased 38% to 269,000 tons, about 70% as met-spar and the balance as acid-spar. Total exports decreased 31% to 233,000 tons, about one-third of which was acid-spar. Exports to Japan also decreased 33% to 140,000 tons, 9% of which was acid-spar. Shipments of met-spar to the U.S.S.R., based on export data, were down 16% to 62,000 tons despite repeal of Revolutionary Decree No. 53 controlling trade with centrally controlled economy countries.

Tunisia.—Production of chemical-grade fluorspar increased 20% to 37,000 tons. However, exports decreased by more than 50% to 12,000 tons.

United Kingdom.—Fluorspar production in 1975 decreased approximately 1% to 254,000 tons. Operations at C.E. Giulini Ltd.'s acid-spar flotation plant and mine at Derbyshire were suspended in August. The plant had been operating since 1972 with annual production at about 40,000 tons. Operations were suspended pending clarification of mining rights in a national forest and also because of environmental problems. Approximately 70% of total British production in 1975 was acid-spar. British Steel Corp., the largest met-spar producer in the United Kingdom, continued development of its new Allenheads mine in eastern Cumbria and finally received permission at midyear to plan construction of a processing plant. A threatened 1977 closing of Laporte Industries Ltd.'s Cavendish mill near Eyam, the largest acid-spar mill in the United Kingdom, was averted by a Government ruling in May allowing construction of a waste disposal lagoon in the Peak District National Forest.

U.S.S.R.—In 1975, fluorspar production increased about 5% to an estimated 525,000 tons, and imports remained at about 540,000 tons. Total estimated consumption was steady at about 1.0 million tons; over three-quarters of this was used in the Soviet steel industry. Expansion of the Yaroslavsk complex in the Maritime Kray was completed in October whereby capacity was doubled to allow processing of about 750,000 tons of ore per year.

No imports were received from Japan and Kenya in 1975; 64,000 tons had been received from these two sources in 1974. Importation of small tonnages of fluorspar began from Western Europe, a total of 14,000 tons being received from Italy and Spain in 1975.

Table 11.—Fluorspar production and exports by major producing country
(Thousand short tons)

	Production		Exports		Met-spar [e] [1] (percent)
	1974	1975	1974	1975	
China, People's Republic of [e]	330	385	350	300	90
France	435	378	162	121	50
Italy	274	255	83	93	10
Mexico	1,226	1,200	1,200	931	40
Mongolia [e]	275	334	275	300	100
South Africa, Republic of	229	223	136	[e] 200	10
Spain	397	411	280	247	30
Thailand	436	269	337	233	70
United Kingdom	257	254	100	3	30
U.S.S.R. [e]	500	525	1	1	50
Total	4,359	4,234	2,924	2,429	
Other countries	988	880	216	[e] 200	
World total	5,347	5,114	3,140	2,629	50

[e] Estimate.
[1] Based on 1975 production.

Table 12.—Fluorspar: World production, by country
(Short tons)

Country [1] and grade [2]	1973	1974	1975 [p]
North America:			
Canada, acid grade [e] [3]	151,000	[r] 175,000	70,000
Mexico:			
Acid grade (exports)	421,975	601,968	[4] 720,128
Metallurgical grade (exports)	700,559	585,381	[4] 480,085
Unspecified [5]	74,458	38,692	--
Total	1,196,992	1,226,041	1,200,213
United States (shipments):			
Acid grade	116,104	77,093	56,944
Metallurgical grade	132,497	124,023	82,969
Total	248,601	201,116	139,913
South America:			
Argentina:			
Acid grade [e]	15,201	[r] 13,450	12,566
Metallurgical grade [e]	35,470	[r] 31,383	29,321
Total	50,671	44,833	41,887
Brazil: [3] [6]			
Direct shipping ore (sales)	3,149	1,555	[e] 1,700
Beneficated product (output)	77,939	67,848	[e] 70,000
Total	81,088	69,403	[e] 71,700
Colombia, grade unspecified	[e] 4,400	(7)	--
Uruguay, grade unspecified	NA	233	72
Europe:			
Czechoslovakia: [3]			
Acid grade [e]	50,000	50,000	50,000
Metallurgical grade [e]	50,000	50,000	50,000
Total [e]	100,000	100,000	100,000
France: [e] [8]			
Acid grade	[r] 205,000	220,000	213,000
Metallurgical grade	[r] 195,000	215,000	165,000
Total	[r] 400,000	435,000	378,000

See footnotes at end of table.

Table 12.—Fluorspar: World production, by country—Continued
(Short tons)

Country [1] and grade [2]	1973	1974	1975 p
Europe—Continued			
Germany, East: [3]			
Acid grade e	r 25,000	r 25,000	25,000
Metallurgical grade e	r 75,000	r 75,000	75,000
Total e	r 100,000	r 100,000	100,000
Germany, West (marketable): [3]			
Acid grade e	90,600	73,531	74,050
Metallurgical grade e	10,902	8,170	8,228
Total	101,502	81,701	82,278
Greece, grade unspecified	1,324	e 1,100	1,102
Italy: [3]			
Acid grade	r 231,048	244,222	227,280
Metallurgical grade	r 28,090	29,692	27,632
Total	r 259,138	273,914	254,912
Romania, metallurgical grade e [3]	17,000	17,000	17,000
Spain: [9]			
Acid grade	r 264,360	278,476	272,621
Metallurgical grade	r 110,975	118,988	e 138,000
Total	r 375,335	397,464	410,621
Sweden: [3]			
Acid grade	2,811	2,470	2,064
Metallurgical grade	2,299	2,021	1,689
Total	5,110	4,491	3,753
U.S.S.R.: [3]			
Acid grade e	240,000	245,000	255,000
Metallurgical grade e	250,000	255,000	270,000
Total e	490,000	500,000	525,000
United Kingdom: [10]			
Acid grade	132,300	136,700	140,000
Metallurgical and ceramic grade	54,000	39,700	36,000
Unspecified	r 63,900	80,400	78,400
Total	r 250,200	256,800	254,400
Africa:			
Egypt, grade unspecified	1,663	1,236	e 1,300
Kenya, metallurgical grade [3]	r 52,911	42,439	60,186
Morocco, grade unspecified	(11)	20,999	52,273
Rhodesia, Southern, metallurgical grade e [3]	165	200	200
South Africa, Republic of:			
Acid grade	204,262	213,369	189,895
Ceramic grade	4,933	5,499	11,347
Metallurgical grade	22,647	10,338	22,067
Total	231,842	229,206	223,309
Tunisia:			
Acid grade	47,735	31,215	37,387
Metallurgical grade	3,633	--	--
Total	51,368	31,215	37,387
Zambia	8	507	e 550
Asia:			
Burma, metallurgical grade	e 220	e 220	--
China, People's Republic of, metallurgical grade e [3]	280,000	r 330,000	385,000
India:			
Acid grade	r e 5,622	5,196	5,468
Metallurgical grade	r e 7,055	6,608	5,794
Total	r e 12,677	11,804	11,262
Japan:			
Acid grade	(7)	(7)	--
Metallurgical grade	(7)	(7)	--
Total	(7)	(7)	--

See footnotes at end of table.

Table 12.—Fluorspar: World production, by country—Continued

(Short tons)

Country [1] and grade [2]	1973	1974	1975 [p]
Asia—Continued			
Korea, North, metallurgical grade [e] [3]	33,000	35,000	35,000
Korea, Republic of, metallurgical grade	[r] 32,934	36,355	31,191
Mongolia, metallurgical grade [e] [3]	265,000	[r] 275,000	334,000
Pakistan, grade unspecified	[r] 934	76	--
Thailand: [12]			
Acid grade	[r] 38,528	60,580	76,631
Metallurgical grade	[r] 377,151	375,623	192,814
Total	[r] 415,679	436,203	269,445
Turkey, metallurgical grade	2,168	[e] 2,200	1,549
Oceania: Australia, grade unspecified	[r] 1,729	262	[e] 265
Grand total	[r] 5,214,659	5,337,018	5,093,768

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

1 In addition to the countries listed, Bulgaria is also believed to have produced fluorspar, but production is not officially reported, and available information is inadequate for formulation of reliable output level estimates.

2 An effort has been made to subdivide production of all countries by grade (acid, ceramic and/or metallurgical). Where the subdivision is available in official reports of the subject country, the data have been entered without qualifying notes; where a secondary source has been used to subdivide production by grade, the source of the basis for this subdivision has been identified by footnote. Where no basis for subdivision is available, the country entry has been identified with the notation "grade unspecified."

3 Information on grade obtained from: Bundesanstalt Für Bodenforschung Hannover and Deutsches Institut Für Wirtschaftsforschung Berlin, Untersuchungen über Angebot und Nachfrage Mineralischer Rohstoffe IV—Flusspat, March 1974, p. 39.

4 Actual reported production; not exports.

5 Figures represent the difference between reported exports (divided by grade) and total production (reported without differentiation by grade), and presumably are domestic consumption plus or minus changes in stocks of both acid and metallurgical grade.

6 Data for Brazil exclude some crude ore mined but neither sold as direct shipping ore nor beneficiated during year specified. Total crude ore production was as follows in short tons: 1973—121,427; 1974—116,705; 1975—NA. Of this output, crude ore beneficiated totaled as follows in short tons: 1973—95,342; 1974—97,044; 1975—NA; producer's initial stocks (as of January 1) totaled as follows in short tons: 1973—1,327; 1974—3,167; 1975—11,704; producer's yearend stocks totaled as follows in short tons: 1973—3,167; 1974—11,704; 1975—NA; and transfers totaled as follows in short tons: 1973—21,096; 1974—9,568; 1975—NA.

7 Revised to zero.

8 Marketed production estimated from domestic consumption and trade does not take into account changes in stocks. Total run-of-mine production (direct shipping ore plus ore destined for concentration) was as follows in short tons: 1973—628,000; 1974—761,000; 1975—805,000. Much of this material requires beneficiation before it becomes a salable product.

9 Spanish figures revised to eliminate duplication detected in previous editions of this chapter.

10 Includes materials recovered from lead-zinc mine dumps.

11 Although official sources record no production, there are indications that at least test lots were produced.

12 Acid grade material reported for Thailand is a beneficiated product resulting from processing low grade material officially reported; metallurgical grade material is run-of-mine material reported under the term "high grade." Recorded production of low grade material was as follows in short tons: 1973—377,151; 1974—375,623; 1975—192,814.

Table 13.—Fluorspar: World trade [1] by source and destination in 1974

(Short tons)

Sources	Destinations								
	Australia [2]	Austria	Belgium-Luxembourg	Canada	France	Germany, West	Italy	Japan	Netherlands
Argentina	--	--	--	--	--	--	--	--	--
Austria [3]	--	XX	--	--	--	--	--	--	--
Belgium-Luxembourg [3]	--	--	XX	--	--	234	--	--	--
Brazil	--	--	--	--	--	--	--	5,853	--
Canada	--	--	--	XX	--	--	--	--	--
China, People's Republic of	8,066	--	--	--	1,533	--	--	197,848	--
France	--	147	9,340	7,288	XX	[4]111,650	22,339	--	1,724
Germany, East	--	1,598	--	--	--	--	--	--	--
Germany, West	--	1,489	5,558	--	988	XX	--	--	331
Italy	--	600	--	--	1,016	30,560	XX	--	[4]2,756
Japan	--	--	--	--	--	--	--	XX	--
Kenya	--	--	--	--	--	--	--	26,761	--
Korea, North	--	--	--	--	--	--	--	6,292	--
Korea, Republic of	--	--	--	--	--	--	--	11,478	--
Malaysia [3]	--	--	--	--	--	--	--	--	--
Mexico	--	--	--	117,877	--	1,150	25,813	--	--
Mongolia	--	--	--	--	--	--	--	--	--
Morocco	--	--	--	--	--	--	--	--	--
Mozambique	--	--	--	--	--	--	--	--	--
Netherlands [3]	--	--	132	--	--	--	--	--	XX
South Africa, Republic of	16,941	--	--	--	--	1,134	--	139,931	--
Spain	--	--	--	4,044	--	62,174	--	--	--
Swaziland	--	--	--	--	--	--	--	--	--
Sweden	--	--	--	--	--	--	--	--	--
Switzerland [3]	--	84	--	--	--	--	--	--	--
Thailand	8,512	--	--	--	--	1,943	--	207,667	[4]7,137
Tunisia	--	--	--	--	--	--	19,127	--	--
Turkey	--	--	--	--	--	5,752	--	--	--
United Kingdom	240	--	419	25,526	1,133	--	--	854	--
United States	1	--	--	2,064	--	--	--	--	--
Unspecified and other	--	--	1,563	--	117	100,082	7,089	--	16,907
Total	33,760	3,918	17,012	156,799	4,787	314,679	74,368	596,684	28,855

See footnotes at end of table.

Table 13.—Fluorspar: World trade[1] by source and destination in 1974—Continued

(Short tons)

Sources	Destinations—Continued							Total receipts by listed country	Total recorded exports
	Norway	Poland	Sweden	U.S.S.R.	United States	Yugoslavia	Other[5]		
					--	--	--	--	1,097
Argentina	--	--	--	--	--	1,042	--	1,042	--
Austria[3]	--	--	--	--					
Belgium-					--	--	[6]227	461	1,456
Luxembourg[3]	--	--	--	--	--	--	[7]606	6,459	34,568
Brazil	--	--	--	--	642	--	--	642	e 660
Canada	--	--	--	--					
China, People's						--	--	351,305	e 350,000
Republic of	1,263	e 40,000	9,075	93,520	--	394	[6]3,200	158,729	161,756
France	--	--	2,647	--	--	3,739	550	16,000	e 17,000
Germany, East	7,717	--	2,396	--	--	394	[6]3,638	13,219	17,534
Germany, West	259	--	562	--	--	464	[7]3,750	79,044	83,237
Italy	--	--	61	--	39,837		2	56,708	[8]67
Japan	--	--	--	51,675	5,031	--	--	39,175	[9]40,806
Kenya	--	--	--	12,414	--	--	217	6,509	e 7,000
Korea, North	--	--	--	--	--	--	[7]265	11,743	10,776
Korea, Republic of	--	--	--	--	--	--	--	--	[9]94
Malaysia[3]	--	--	--	--	1,064,158	--	--	1,208,998	e 1,200,000
Mexico	--	--	--	275,453	--	--	--	275,453	e 275,000
Mongolia	--	--	--	--	5,458	--	--	5,458	6,063
Morocco	--	--	--	--	20,636	--	--	20,636	e 21,000
Mozambique	--	--	--	--	--	--	7,179	7,311	243
Netherlands[3]	--	--	--	--					
South Africa,			400	--	3,035	--	--	161,441	136,232
Republic of	--	--		--	188,280	--	[6]3,511	262,672	279,983
Spain	4,663	--	--	--	--	--	17,533	17,533	e 18,000
Swaziland	--	--	--	--	--	--	[6]69	69	388
Sweden	--	--	XX	--	--	249	--	333	[9]317
Switzerland[3]	--	--	--	--	--	--	[6]5,348	274,641	336,801
Thailand	--	--	--	44,034	--	--	--	28,438	28,182
Tunisia	--	--	--	--	9,311	--	--	5,752	e 6,100
Turkey	--	--	--	--	--	6	1,854	62,030	100,082
United Kingdom	31,300	--	698	--	--	--	[6]100	51,623	5,847
United States	--	--	--	49,458	XX				
Unspecified and								136,652	--
other	183	--	--	10,711	--	--	--		
Total	45,385	e 40,000	15,839	537,265	1,336,388	6,288	48,049	3,260,076	3,140,289

e Estimate. XX Not applicable.

[1] Compiled from official import data of listed countries of destination except where otherwise specified by footnote; figures in total receipts by listed countries column are simply summations of reported imports for all listed destinations, in contrast to figures in total recorded exports column which are either (1) actual reported exports of listed source countries, or (2) estimates of total exports. Differences between these two columns are attributed to (1) time lag between date of shipment and date of receipt, (2) concealment policies of some countries, and/or (3) reshipment of material by intermediate countries which may be credited as the origin in the trade returns of the final destination countries.

[2] Imports for year beginning July 1, 1974.

[3] No recorded production of fluorspar; exports are apparently derived from imported materials.

[4] Official import statistics show no receipts from this country, but do include a substantial quantity of material from undisclosed sources. Figure entered here represents reported export of source country to this destination. (An equal amount has been subtracted from the destination country's reported import from undisclosed sources).

[5] Data compiled from official import statistics of six nations and export statistics of 10 significant producing nations, the latter to determine apparent imports for 15 other countries for which official fluorspar import figures are not available. Nations reporting imports and total recorded imports for each are as follows in short tons: Brazil 68,614; Denmark 2,611; Finland 5,721; India 18,061; Mexico 30; Spain 19. Nations for which apparent imports have been derived, and apparent imports for each are as follows in short tons: Algeria 112; Argentina 606; Bulgaria 357; Hungary 1,929; Indonesia 65; Philippines 496; Romania 3,392; Singapore 110; the Republic of South Africa 61; Switzerland 2,319; Taiwan 3,932; Thailand 165; Turkey 391; Venezuela 18; Vietnam 539.

[6] Figure compiled from both the official import statistics of the countries of destination and official export statistics for the country of origin (see footnote 5).

[7] Figure compiled exclusively from official export statistics of the country of origin (see footnote 5).

[8] Figure includes fluorspar as well as any nepheline and/or nepheline syenite exported.

[9] Figure includes fluorspar as well as any feldspar, nepheline and/or nepheline syenite exported.

TECHNOLOGY

The National Academy of Sciences began a study on the possible depletion of the protective ozone in the earth's upper atmosphere by reaction of the ozone with chlorofluorocarbon-decomposition products. Chlorofluorocarbon levels measured by the University of Denver[5] at 60,000 feet over New Mexico indicated an average increase of 14% per year during the period 1968 to 1975. This rate of increase was noted to be about the same as the average annual increase in chlorofluorocarbon use.

The Federal Bureau of Mines continued studies on recovery of byproduct H_2SiF_6 from phosphate rock processing for fertilizer manufacture. A semicontinuous process was being evaluated on a small scale using recycled phosphoric acid rather than sulfuric acid for acidulation of the rock. About 80% of the fluorine in the feedstock was evolved as water-scrubbable gaseous H_2SiF_6. Commercial processing recovers less than 50% of the fluoride in phosphate rock.

The amount of fluorspar flux used per ton of steel was reduced by more efficient utilization and by mixing fluorspar with less desirable substitutes such as ilmenite, olivine, and colemanite. However, no universal substitute has been found for fluorspar in steel manufacture.

A new British technique was reported[6] for converting fluosilicic acid into hydrogen fluoride. The process was claimed to accept very dilute, 2% fluosilicic acid or less, offstreams from phosphate rock processing and involves conversion to ammonium fluoride, then to alkali fluorides, and finally to hydrogen fluoride. The process has been demonstrated only on a small scale.

Three new applications of fluorocarbons in medical technology were reported.[7] The potential of gaseous chlorofluorocarbon gases as inhaled anesthetics was demonstrated on animals, and possible marketing by 1982 was indicated. Use of liquid fluorocarbons as replacements for blood was demonstrated in monkeys; life-sustaining oxygen was transported in solution in the liquid. Use of brominated fluorocarbons in radiography of lungs, the gastrointestinal tract, and the central nervous system was demonstrated with humans; the material is less toxic than the barium and iodine organic compounds now in use.

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[5] Technology Newsletter. Balloon Studies Show Fluorocarbons Increase. Chemical Week, v. 117, No. 26, 1975, p. 27.

[6] Chemical Engineering. A New Technique To Convert Fluosilicic Acid (FSA) to Anhydrous Hydrogen Fluoride. V. 82, No. 6, Mar. 17, 1976, p. 19.

[7] Chemical Week. Fluorocarbons Seek Medical Role. V. 117, No. 12, Sept. 17, 1975, p. 39.

Gallium

By Benjamin Petkof [1]

Domestic gallium production increased above that of 1974. Although data on rest-of-world gallium production were not available, it was believed to have declined. Most gallium consumption continued to be in the production of various gallium compounds used to produce gallium-based electronic devices.

Table 1.—Salient gallium statistics in the United States
(Kilograms)

	1972	1973	1974	1975
Production	W	W	W	W
Imports for consumption	6,066	11,124	6,536	6,830
Consumption	5,076	8,496	r 6,939	7,493
Price per kilogram dollars	750	750	750	750–800

r Revised. W Withheld to avoid disclosing individual company confidential data.

DOMESTIC PRODUCTION

Domestic gallium production increased significantly from that of 1974, but data cannot be published in order to avoid disclosing individual company operations. Two companies produced metallic gallium in 1975. The Aluminum Co. of America (Alcoa), using proprietary gallium production technology, produced metal at its Bauxite, Ark., plant as a byproduct from residues of its alumina production process. Eagle-Picher Industries Inc. produced gallium metal, oxide, and trichloride from zinc production residues at its Quapaw, Okla., facility. Canyonlands 21st Century Corp. reprocessed gallium from gallium arsenide at its plant in Blanding, Utah. Other domestic companies produced high-purity gallium metal and gallium compounds such as arsenide, oxide, phosphide, and trichloride for the manufacture of electronic devices. Increasing demand for gallium-based devices by the electronics industry was expected to stimulate future domestic gallium production.

CONSUMPTION

Total domestic gallium consumption increased 8% in 1975. Almost the entire consumption of high-purity gallium metal was used to manufacture light-emitting diodes and semiconductor devices; the remainder was used for research and development, and the preparation of dental alloys. A small quantity of commercial-grade material was also used for research and development. Gallium in intermetallic compounds (arsenide, phosphide, and arsenide-phosphide) was also used for the manufacture of light-emitting diodes and semiconductor devices. Gallium in the form of oxide was used for the preparation of phosphors.

The wide acceptance of devices such as solid state calculators, digital clocks and watches, and visual display instrumentation using gallium-based components has greatly stimulated the demand for gallium. In addition, the capability of producing gallium-based, light-emitting diodes of various colors and the metal's potential use for solar cells for the production of electricity will probably enhance the future demand for gallium.

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[1] Physical scientist, Division of Nonferrous Metals.

Table 2.—Consumption of gallium by end use

(Grams)

End use	1974	1975
Alloys [1]	5,357	7,050
Electronics [2]	r 6,700,654	7,338,100
Research and development	112,307	91,156
Unspecified uses	120,500	56,500
Total	r 6,938,818	7,492,806

r Revised.
[1] Specialty alloys.
[2] Light-emitting diodes, semiconductors, and other electronic devices.

STOCKS

Consumer stocks of gallium metal at yearend 1975, both commercial and high-purity grades, shown in table 3, increased 68% over beginning stocks. Gallium metal stocks held by producers and suppliers at yearend are shown in the following tabulation:

Yearend—	*Grams*
1971	402,875
1972	1,005,945
1973	948,947
1974	4,037,917
1975	2,727,179

Table 3.—Stocks, receipts, and consumption of gallium

(Grams)

Purity	Beginning stocks [1]	Receipts	Consumption	Ending stocks [1]
1974:				
97.0%–99.9%	r 13,812	r 12,000	7,433	18,379
99.99%	r 2,178	r 1,491	343	3,326
99.999%	r 52,491	r 6,340	53,413	5,418
99.9999%–99.99999%	r 781,013	r 6,631,224	r 6,877,629	r 534,608
Total	r 849,494	r 6,651,055	r 6,938,818	r 561,731
1975:				
97.0%–99.9%	18,379	--	9,137	9,242
99.99%	[2] 3,591	3,054	3,468	3,177
99.999%	[2] 5,478	57,162	59,931	2,709
99.9999%–99.99999%	[2] 521,744	7,807,980	7,420,270	909,454
Total	[2] 549,192	7,868,196	7,492,806	924,582

r Revised.
[1] Consumers only.
[2] Ending stocks for 1974 do not equal 1975 beginning stocks because of reported beginning stock adjustments.

PRICES

Prices paid for gallium are subject to negotiation between buyer and seller and are not reported. However, during the year, the American Metal Market quoted metal of 99.999% purity at $750 to $800 per kilogram in 100-kilogram lots.

FOREIGN TRADE

Data on exports of gallium materials are not reported separately and are included in the category, "base metals and alloys, not elsewhere classified, wrought or unwrought, waste and scrap."

Total U.S. imports of gallium increased about 5% in quantity and decreased 13% in value from that of 1974. Gallium from the Netherlands and Switzerland accounted for 92% of imports. The average value of imports was $520 per kilogram.

Table 4.—U.S. imports for consumption of gallium (unwrought, waste and scrap), by country

Country	1974		1975	
	Kilograms	Value	Kilograms	Value
Belgium-Luxembourg	2	$1,502	--	--
Canada	59	38,070	242	$129,745
Czechoslovakia	--	--	5	1,400
Germany, West	(1)	1,415	--	--
Italy	--	--	254	100,512
Japan	4	12,073	42	64,000
Netherlands	267	163,992	269	147,920
Switzerland	6,153	3,856,442	6,001	3,103,364
United Kingdom	51	33,248	17	8,414
Total	6,536	4,106,742	6,830	3,555,355

[1] Less than ½ unit.

WORLD REVIEW

World production data for gallium are not available, but gallium production probably followed the general world economy and declined during 1975.

Germany, West.—Swiss Aluminium Ltd. stated in its annual company report that there was a strong decline in its gallium business and production was curtailed at its Bergheim-Erft plant. The company also reported that demand picked up at yearend but at depressed prices.

Peru.—A recent report provided an estimate of the gallium resources available in the country's zinc resources. Reserves were reported as 660 metric tons and indicated resources, 1,660 metric tons. This provided a total national resource of 2,320 metric tons.[2]

TECHNOLOGY

The experimental production of a more efficient gallium-arsenide solar cell was announced. The cell, 1/3-inch in diameter, produced 10 watts of electricity by using highly concentrated sunlight. A 20% efficiency was claimed for the conversion of sunlight to electrical energy.[3]

A method was developed to recover gallium from solutions formed by the caustic digestion of bauxite. The solution was treated with carbon dioxide to precipitate alumina and gallium oxide. The precipitates were recirculated through additional solution for a long period of time in order to precipitate additional gallium oxide from solution.[4]

Vapor-phase epitaxy was used to grow gallium arsenide on a germanium substrate. The initial growth of the gallium arsenide layer was described.[5] Rapid growth in the first 5 minutes covered the substrate with a gallium arsenide layer that was built up at a steady rate. Scanning electron micrographs of the gallium arsenide layers revealed that the substrate surface was chemically attacked.

Analytical chemical methods for determining gallium were described.[6]

A report presented some thermodynamic properties of gallium-antimony alloys.[7]

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[2] Damiani, O. Mineral Resource Potential of Peru. World Mining Congress, Lima, Peru, Aug. 3, 1974. 15 pp.

[3] Wall Street Journal. Varian Associates Says It Developed Efficient Solar Cell. V. 185, No. 123, June 25, 1975, p. 14.

[4] Snyder, H. C., Jr. (assigned to the Aluminum Co. of America). Recovery of Gallium. U.S. Pat. 3,897,538, July 29, 1975.

[5] Ceramic Abstracts. Initial Growth of GaAs on (100) Germanium. V. 55, No. 3-4, March–April 1976, p. 89.

[6] Busev, A. I., V. G. Tiptsova, and V. M. Ivanov. Handbook of the Analytical Chemistry of Rare Elements. Ann Arbor-Humphrey Science Publishers, Inc., Ann Arbor, Mich., 1970, pp. 247–258.

[7] Ceramic Abstracts. Thermodynamic Properties of Gallium+Antimony. V. 55, No. 3-4, March–April 1976, p. 93.

Gem Stones

By Robert G. Clarke [1]

The value of gem stones and mineral specimens produced in the United States during 1975 was estimated to be $8.7 million, an increase of 90% over that of 1974. The domestic commercial mining industry contributed most of the increase, particularly in the production of turquoise. Amateur collectors accounted for much of the activity in many States. Commercial operators sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 39 States produced gem materials estimated at $1,000 or more in value for each State. Ten States supplied 91% of the total value, as follows: Arizona, $5 million; Nevada, $1 million; Oregon, $500,000; Montana, $400,000; California, $220,000; New Mexico, $200,000; Texas, $160,000; Washington, $160,000; Wyoming, $140,000; and Colorado, $135,000.

Park authorities at the Crater of Diamonds Park in Arkansas reported the finding of the second largest diamond ever found in the area.[2] The diamond, 16.37 carats in weight, was flawless and clear white. The rough value was placed at $15,000; when finished, the stone will be worth $80,000 to $100,000.

Several minute diamond crystals were discovered in a rock sample from a diatreme in Wyoming, according to geologists who have been examining pipelike intrusions of igneous rock in the Rocky Mountain area.[3]

In Nevada, the explosion in demand for turquoise jewelry resulted in an increased value of gem stone production of 150% from an estimated $400,000 in 1974 to $1 million in 1975. To help individuals learn more about collecting localities in Nevada, a "map" was published of the State's rocks and minerals.[4]

The quantity and value of emerald, jade, opal, and sapphire were withheld to maintain confidentiality of reporting producers. Peridot was produced by about 200 individuals of the San Carlos Apache Tribe at Peridot, Ariz.; no estimate of quantity and value of the peridot was available.

The production of turquoise of all grades and quantities was nearly 586 tons, valued at $5.2 million, and was principally from Arizona, Colorado, and Nevada. The great interest in American Indian style jewelry continued throughout 1975. Many articles appeared in various publications describing the qualities of genuine turquoise and Indian jewelry.

The discovery of tourmaline in Maine initially occurred in August 1972. The discovery and subsequent development were described in detail.[5] Tourmaline has appeared in jewelry stores occasionally in the past, but the discovery at Newry assured a regular supply. Retail prices in

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[1] Physical scientist, Division of Nonmetallic Minerals.

[2] Arkansas Gazette. Little Rock, Ark. Record Diamond Found in Park. Aug. 21, 1975, sec A, p. 1.

[3] U.S. Geological Survey. Diamond Discovered in Wyoming. News Release, June 10, 1975.

[4] Nevada Bureau of Mines and Geology. Rockhound's Map of Nevada. Spec. Pub. 1, 1975.

[5] Dunn, P. J. Elbaite From Newry, Maine. Miner. Record, v. 6, No. 1, January-February 1975, pp. 22–25.

MacFall, R. P. Gem Tourmaline . . . Rediscovered at Newry. Miner. Record, v. 6, No. 1, January-February 1975, pp. 14-21.

——. The Story Beyond the Story of the Great Tourmaline Discovery. Lapidary J., v. 29, No. 5, August 1975, pp. 994–1001.

1975 ranged from about $8 per carat for small, slightly flawed stones to $100 per carat for large stones of good color weighing about 50 carats.

In addition to emerald, North Carolina is also the source for rhodolite, a garnet varietal. Western North Carolina is invariably associated with rhodolite garnets and probably the world's only supplier. A description of the area where rhodolite is found was published with complete instructions for gem seekers at the dig-for-fee mine.[6]

Accurate and up-to-date information for collecting areas is difficult to maintain. A listing of fee-basis and free digging areas for agate and other gem materials in central Oregon was provided with the cautionary advice to inquire in advance to verify the information.[7]

Custer, S. Dak., has been called the rose quartz capital of the world. In addition, four totally new minerals were discovered in the area: Jahusite, robertsite, segelerite, and wylheite.[8]

Producers of gem stones in the United States, by principal gem stone reported, follow:

[6] Broughton, P. L. North Carolina's Mason Mountain Rhodolites. Gems and Minerals, No. 453, July 1975, pp. 30–31.
[7] Shipp, M. D. Digging in Central Oregon 1975. Lapidary J., v. 29, No. 4, July 1975, pp. 870–871.
[8] Linde, M. South Dakota Mineral News. Gems and Minerals, No. 452, June 1975, pp. 32–33, 61–64.

Mine	Location	Operator
Emerald: Big Crabtree mine	Mitchell County, N.C	PBH Emerald Co. P.O. Box 163 Little Switzerland, N.C. 28749
Jade: Stewart Jewel Jade mine	Kobuk Village, Alaska	Stewart Jewel Jade Co. 531 4th Ave. Anchorage, Alaska 99501
Opal:		
Royal Peacock mine	Humboldt County, Nev	Harry W. Wilson Denio, Nev. 89404
Spencer Opal mine (dig-for-fee mine).	Clark County, Idaho	Mark L. Stetler 1862 Ranier St. Idaho Falls, Idaho 83401
Sapphire:		
Chaussee Sapphire mine (sold unscreened material to tourists in summer and assisted in screening).	Granite County, Mont	Chaussee Sapphire Corp. P.O. Box 706 Philipsburg, Mont. 59858
Sapphire Village mine (Yogo Gulch).	Judith Basin County, Mont.	Sapphire International Corp. P.O. Box 30 Utica, Mont. 59452
Turquoise:		
Aurora mine	Lander County, Nev	Carico Lake Mining Co. P.O. Box 3426 Albuquerque, N. Mex. 87110
Black Spider mine	do	Grillos Mining Co. 2221 10th St. Lubbock, Tex. 79401
Blue Eagle mine	Mineral County, Nev	E. Loving and D. Lester P.O. Box 155 Mina, Nev. 89422
Blue Jim mine	Lander County, Nev	James Elquist P.O. Box 255 Battle Mountain, Nev. 89820
Blue Spider mine	do	John Lee & Co. 5101 North 40th St., Apt. 119 Phoenix, Ariz. 85018
Boundary mine	Mineral County, Nev	D. Brannon and R. H. Herrington P.O. Box 377 Mina, Nev. 89422
Duval Corp. mine	Mohave County, Ariz	L. W. Hardy Co., Inc. 3809 East Highway 66 Kingman, Ariz. 86401
Morenci mine	Greenlee County, Ariz	W. O. Brown 230 West 66 Avenue Gallup, N. Mex. 87301
Pinto Valley mine	Gila County, Ariz	L. W. Hardy Co., Inc. 3809 East Highway 66 Kingman, Ariz. 86401
Red Mountain mine	Lander County, Nev	J. M. Johnson 102 West 9th Place Mesa, Ariz. 85201 Turquoise Nugget (colessee) P.O. Box 1118 Flagstaff, Ariz. 86001

Mine	Location	Operator
Turquoise—Continued		
Royal Blue mine	Esmeralda County, Nev	R. C. Wilcox P.O. Box 1311 Tonopah, Nev. 89049
Shoshone and Ackerman mines	Churchill County, Nev	Lombardo Turquoise Co., Inc. 1300 East Main St. Austin, Nev. 89310
Turquoise Chief mine	Lake County, Colo	N. F. Reed Albuquerque, N. Mex. 87110
Villa Grove mine	Saguache County, Colo	G. Musick P.O. Box 174 Villa Grove, Colo. 81155

CONSUMPTION

Domestic gem stone output was utilized for amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) was $468 million, about 17% more than in 1974.

PRICES

Typical costs to a retail jeweler in December 1975 for representative better quality gem stones as reported by 15 typical importers follow: [9]

Gem stone	Carat weight	Median price per carat	Price range per carat
Amethyst	10	$12	$8–$20
Aquamarine	8	95	50–250
Black opal	3	450	200–1,500
Cat's eye	5	1,000	700–1,250
Citrine	10	5	4–8
Emerald	1	1,700	750–12,000
Green garnet	1	425	400–500
Man's sky blue star	10	225	85–500
Peridot	10	45	25–70
Ruby	2	2,000	850–15,000
Sapphire	2	650	350–3,500
Tanzanite	5	200	200–260
Tourmaline, green	10	55	30–80
Tourmaline, pink	10	70	25–90
White opal, fiery	5	65	35–120

NOTES.—Ten-carat cat's eyes and 15-carat peridot, both of which were on the 1974 list, became unavailable during 1975, but the median price per carat of the smaller stones held at the levels of the larger stones.

No survey was made of diamond prices; price trends indicated higher prices for cut diamond 1 carat and smaller, but no change in larger cut diamond.

FOREIGN TRADE

Exports of all gem materials amounted to $257.2 million, and reexports to $133.7 million. Diamond accounted for 92% of the value of both exports and reexports. Exports of diamond totaled 264,873 carats valued at $237.0 million. Of this total, diamond cut but unset, suitable for gem stones, not over 0.5 carat, was 50,180 carats valued at $15.2 million; and cut but unset, over 0.5 carat, was 209,427 carats valued at $220.7 million.

Reexports of diamond amounted to 1,178,482 carats, valued at $122.7 million, in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,049,903 carats valued at $79.4 million; cut but unset, not over 0.5 carat, 44,089 carats valued at $10.1 million; cut but unset, over 0.5 carat, 84,490 carats, valued at $33.1 million.

The eight leading recipients of diamond exports accounted for 84% of the carats

[9] Jewelers' Circular-Keystone. JC-K's Colored Stone Price Index. V. 146, No. 4, January 1976, p. 124.

and 96% of the value and were as follows: Hong Kong, 82,136 carats valued at $94.3 million; Japan, 40,484 carats, $33.5 million; Switzerland, 40,643 carats, $31.8 million; the Netherlands, 21,894 carats, $24.9 million; Belgium, 13,986 carats, $20.5 million; France, 6,598 carats, $9.3 million; West Germany, 3,885 carats, $7.6 million; and the United Kingdom, 12,878 carats, $6.5 million.

The eight leading recipients of diamond reexports accounted for 97% of both carats and value and were as follows: Israel, 506,473 carats valued at $35.0 million; Belgium, 363,304 carats, $33.4 million; the Netherlands, 181,990 carats, $21.7 million; Switzerland, 7,343 carats, $7.1 million; the United Kingdom, 45,784 carats, $6.9 million; Japan, 9,472 carats, $6.2 million; Hong Kong, 8,953 carats, $4.7 million; and France, 18,578 carats, $3.8 million.

Exports of all other gem materials amounted to $20.2 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.4 million. Natural precious and semiprecious stones, unset, were valued at $16.7 million; and synthetic or reconstructed stones, unset, were valued at $3.1 million. Reexports of all other gem materials amounted to $19.9 million in categories as follows: Pearls, $10.0 million; natural precious and semiprecious stones, unset, $9.8 million; synthetic or reconstructed stones, unset, $0.1 million.

Imports of gem materials decreased about 4% in value from those of 1974. Diamond accounted for 85% of the total value of gem material imports.

Although rough and uncut diamond imports were reported from 22 countries, over 99% of the value was from 10 areas, as follows: The Republic of South Africa, 926,738 carats, $189.9 million; the United Kingdom, 450,689 carats, $70.0 million; Sierra Leone, 272,331 carats, $32.7 million; the Netherlands, 36,132 carats, $13.6 million; Belgium-Luxembourg, 30,988 carats, $8.3 million; Venezuela, 389,146 carats, $8.2 million; Southwest Africa, 36,206 carats, $6.6 million; Israel, 32,574 carats, $5.5 million; Central African Republic, 134,068 carats, $5.3 million; and Liberia, 3,870 carats, $5.0 million.

Cut but unset diamond, not over 1/2 carat, was imported from 35 countries; however, the imports of this category from 8 countries amounted to 98% of total carats and value as follows: Israel, 834,875 carats, $125.7 million; Belgium, 729,438 carats, $105.4 million; India, 299,214 carats, $36.9 million; the U.S.S.R., 44,634 carats, $9.1 million; the Netherlands, 48,194 carats, $6.4 million; the Republic of South Africa, 14,254 carats, $4.0 million; the United Kingdom, 15,836 carats, $2.1 million; and France, 17,910 carats, $2.0 million. Cut but unset diamond, over 1/2 carat, was imported from 32 countries; the imports from 6 countries amounted to 98% of total carats and value as follows: Belgium, 121,122 carats, $48.6 million; Israel, 72,606 carats, $22.6 million; the Republic of South Africa, 7,636 carats, $4.5 million; the Netherlands, 10,183 carats, $3.9 million; the U.S.S.R., 12,831 carats, $3.8 million; and the United Kingdom, 1,094 carats, $0.5 million.

Imports of emeralds decreased 7% in quantity but increased 19% in value. Emeralds were imported from 33 countries of which the 10 leading countries accounted for 94% of the carats and 92% of the value. In order of value these countries were as follows: Colombia, $13.0 million; India, $6.8 million; Switzerland, $4.6 million; Hong Kong, $3.3 million; Brazil, $2.9 million; France, $2.2 million; the United Kingdom, $1.3 million; Sri Lanka, $1.3 million; Israel, $1.0 million; and West Germany, $0.8 million. Imports of rubies and sapphires decreased 9% in value from those of 1974. Ruby and sapphire imports were reported from 36 countries of which the 7 leading countries accounted for 95% of the value as follows: Thailand, $12.3 million; Sri Lanka, $1.9 million; Hong Kong, $1.2 million; India, $1.1 million; Switzerland, $1.0 million; the United Kingdom, $0.4 million; and France, $0.4 million. Natural pearls and parts from 12 countries increased 53% in value of imports; 4 countries accounted for 97% of the value as follows: Canada, $63,000; India, $365,000; Burma, $157,000; and Japan, $67,000. Cultured pearls, on the other hand, decreased 18% in value of imports, which were received from 16 countries, although Japan, at $7.0 million, accounted for 97% of the value. Imports of imitation pearls decreased 49% in value; Japan, at $469,000, accounted for 91% of the value. Coral, cut but unset, along with cameos suitable for use in jewelry, more than doubled in value of imports, which were received from 19 countries; 3 countries accounted for 97% of the value as follows: Italy, $4.9 million; Japan, $0.8 million; and Taiwan, $0.5 million.

Imports of other precious and semiprecious stones, rough and uncut, increased 37% in value and came from 41 countries of which 6 countries accounted for 75% of the value as follows: Brazil, $1.8 million; Colombia, $1.0 million; Australia, $1.0 million; the Republic of South Africa, $0.5 million; Tanzania, $0.3 million; and Venezuela, $0.2 million. Other precious and semiprecious stones, cut but unset, decreased only 1% in value and were imported from 58 countries, of which 7 countries accounted for 84% of the value as follows: Hong Kong, $10.6 million; Brazil, $3.6 million; West Germany, $3.1 million; Australia, $2.7 million; Taiwan, $1.7 million; India, $1.2 million; and Iran, $1.1 million. Synthetic gem stones, cut but unset, increased 27% in value and came from 19 countries of which 7 accounted for 99% of the value as follows: West Germany, $4.8 million; Switzerland, $0.7 million; Japan, $0.7 million; France, $0.6 million; Hong Kong, $0.6 million; Taiwan, $0.3 million; and Austria, $0.2 million. Imitation gem stones decreased 27% in value from 24 countries; 5 countries accounted for 99% of the value as follows: Austria, $3.3 million; West Germany, $2.8 million; Czechoslovakia, $1.1 million; Japan, $0.7 million; and Hong Kong, $0.3 million.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1974		1975	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut	2,450	412,678	2,341	347,882
Cut but unset	2,083	347,362	2,236	374,237
Emeralds: Cut but unset	871	34,046	806	40,348
Coral, cut but unset, and cameos suitable for use in jewelry	NA	3,082	NA	6,475
Rubies and sapphires: Cut but unset	NA	20,960	NA	19,069
Marcasites	NA	249	NA	23
Pearls:				
Natural	NA	440	NA	673
Cultured	NA	8,874	NA	7,261
Imitation	NA	1,019	NA	515
Other precious and semiprecious stones:				
Rough and uncut	NA	4,646	NA	6,380
Cut but unset	NA	29,083	NA	28,718
Other n.s.p.f	NA	1,851	NA	1,935
Synthetic:				
Cut but unset .... number	9,271	6,316	13,682	8,008
Other	NA	362	NA	610
Imitation gem stones	NA	11,352	NA	8,296
Total	NA	882,320	NA	850,430

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1973				1974				1975			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Angola	--	--	--	--	(1)	15	--	--	4	609	--	--
Belgium-Luxembourg	68	16,836	1,159	177,317	43	14,804	953	162,926	31	8,250	849	153,276
Brazil	(1)	6	2	409	1	535	4	642	5	982	3	491
Canada	1	276	1	91	(1)	(1)	(1)	52	--	--	1	156
Central African Republic	191	7,668	--	--	132	6,766	--	--	134	5,298	--	--
France	6	169	24	2,441	31	5,668	20	2,150	7	231	18	2,195
Germany, West	1	301	1	94	1	72	2	207	--	--	1	281
Hong Kong	--	--	6	1,006	(1)	65	5	772	--	--	5	847
India	(1)	21	213	23,099	--	--	221	26,709	--	--	300	37,211
Israel	34	7,838	852	128,204	37	8,052	774	128,856	33	5,523	902	147,114
Japan	1	36	2	286	1	77	4	854	1	77	2	428
Liberia	7	5,192	(1)	406	6	8,683	(1)	5	4	4,981	--	--
Netherlands	55	22,209	18	4,143	51	19,193	32	4,948	36	13,643	58	9,860
Portugal	(1)	40	--	--	1	408	(1)	1	5	570	2	473
Sierra Leone	[2]747	[2]78,919	(1)	40	453	57,577	1	82	272	32,696	(1)	83
South Africa, Republic of	427	83,707	24	12,833	389	68,948	23	9,786	927	189,885	21	7,777
Switzerland	1	181	5	1,429	2	251	8	1,587	(1)	42	4	1,087
U.S.S.R	--	--	30	5,931	--	--	15	3,609	--	--	43	9,215
United Kingdom	979	225,802	20	2,415	911	211,799	19	3,209	451	69,959	17	2,576
Venezuela	296	9,839	(1)	12	383	8,215	(1)	20	389	8,204	(1)	5
Western Africa, n.e.c	--	--	--	--	1	883	--	--	36	6,568	--	--
Zaire	--	--	--	--	2	200	(1)	18	3	152	--	--
Other	7	1,158	3	831	5	467	2	929	3	212	10	1,162
Total	[2]2,821	[2]460,198	2,360	360,987	2,450	412,678	2,083	347,362	2,341	347,882	2,236	374,237

[1] Less than ½ unit.
[2] Adjusted by the Bureau of Mines.

WORLD REVIEW

Angola.—The production of diamond in Angola declined in 1975 owing to the political chaos caused by the collapse of public authority following the exodus of the Portuguese. The principal diamond producing company was the Portuguese firm, Companía de Diamantes de Angola (Diamang), which was reported to be in financial difficulties.[10] Diamang's production was from alluvial diamond-bearing gravels in areas drained by the major river systems of central and southern Angola. Stripping was the mining method used, and was accomplished by mechanical excavators and hydraulic monitors, as well as manual shovels.

Australia.—It was estimated that 95% of the amount of opal used in jewelry in the world comes from six deposits in Australia.[11] More than half of the production is from the area of Coober Pedy. In 1973, the value of opal exported from Australia was officially reported to be $27 million, but unofficial estimates were much higher. It is simple to smuggle out high-quality opal following cash and carry deals. Mining methods have been mostly by hand digging to be gentle with the opal. Lately, however, bulldozers and rippers have been used to strip the surface, and then hand digging is used to remove opal as it is exposed.

The Mining Houses of Australia Ltd., having ceased sapphire mining operations, offered to sell its sapphire stockpile to shareholders to liquidate its inventories.[12] However, a strong recovery in the sapphire market led to Dominion Mining's resumption of full-scale operations at its Frazers Creek property in New South Wales.

Botswana.—The Government of Botswana and De Beers Botswana Mining Co. concluded negotiations relating to the terms governing diamond mining at Orapa and Letlhakine (formerly the DK 1 and DK 2 complex).[13] Production at Orapa will be increased to 4.5 million carats per year by 1979 from the present 2.4 million carats. The Letlhakine mine is expected to produce about 400,000 carats annually by 1979.

At Orapa in 1975, the tonnage treated was 3,359,832 short tons, compared with 2,953,628 tons treated in 1974.[14] The recovery grade was 79.19 carats per 110 short tons, compared with 92.03 carats per 110 tons in 1974. Two X-ray sorting machines were in use, and two additional machines were being installed in a new circuit.

Brazil.—Results of a 4-year aerial infrared photographic survey of the Amazon region indicated areas suitable for prospecting for diamond in the Tumucumaque mountains and in Roraima. This prompted Anglo American Corp. (AAC) to join Income (Bethlehem Steel Corp./Hanna Mining Corp.) to form Sopermi (40% AAC, 60% Income), an exploration firm which is active in Minas Gerais and Mato Grasso.[15]

Canada.—No occurrences of precious gem stones have been found in Canada, but a variety of other gem stone minerals are available. The main geological regions and some important gem stone areas were described in an article which was well illustrated by color photographs.[16]

Central African Republic.—The output of diamond in 1975 in the Central African Republic was 339,000 carats, about the same as in 1974, and the value was $14.7 million compared with $14.4 million in 1974. In spite of lower dollar exchange rates, the income was higher owing to improved gem stone quality and increased prices of diamond.

Diamond in the Central African Republic, to date, has been mined in alluvial fans, basins, water courses, and streambeds. Because these formations are not conducive to large-scale mining operations, most diamond mining has been by individuals and small groups. However, diamond recovery at these small operations has become more difficult, and a shift to large-scale operations was needed, requiring larger capital expenditures. To maintain and expand production, Diamond Distributors International Inc. (United States), Cominco, Ltd. (Canada), and the Government of the Cen-

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[10] Mining Journal. Diamang. How Much Longer? V. 286, No. 7330, Feb. 13, 1976, p. 129.

[11] Hartley, W. D. Dreams of Striking It Rich Sustain Men Bitten by Opal Fever. Wall Street Journal, v. 185, No. 9, Jan. 14, 1975, pp. 1, 26.

[12] Mining Journal. Sapphire Dividends? V. 284, No. 7293, May 30, 1975, p. 422.

[13] Bureau of Mines. Diamond: Botswana. Mineral Trade Notes, v. 72, No. 11, November 1975, p. 4.

[14] De Beers Consolidated Mines Limited. 1975 Annual Report. 59 pp.

[15] Mining Journal. AAC: Brazilian Diamond Interest. V. 284, No. 7295, June 13, 1975, p. 463.

[16] Steacy, H. R. Canada's Beautiful, Little Known Gemstones. Canadian Geog. J., December 1974.

tral African Republic established a local firm, Société Centrafricaine d'Exploitation Diamantifére (SCED), in late 1973 to meet these objectives. SCED has had two successful years and has been largely responsible for maintaining the production of diamond in the Republic at the 1974–75 levels.

The quality of diamond is good as 60% to 70% are of gem grade. Most stones are exported uncut to Europe, Israel, or the United States. Skilled Central African artisans in Black Africa's only diamond cutting factory cut about 5% of the gem diamond production. In 1974, diamond exports to the United States were valued at $6.8 million for gem quality and $464,000 for industrial diamond. Diamond exports comprise an important element in the foreign exchange earnings and tax revenues of the Republic. Over the past 10 years about 30% of its foreign exchange earnings have been from diamond exports.

Colombia.—Bids were invited from private companies for mining rights at the three largest emerald deposits in the Department of Boyacá, at Muzo, Coscuez, and Peñas Blancas, which have been closed since Empresa Colombiana de Minas (Econominas) ceased operations in July 1973.[17] The successful companies, which must be at least 51% Colombian owned, would have an initial lease for 5 years with the possibility of an extension for a further 3 years; Econominas will continue to be responsible for overall control of the deposits. The mining district was described as too rich for a poor country, leading to violence.[18]

Ghana.—The total production of diamond in Ghana is probably fifth in the ranking of countries in the world, but nearly 90% of Ghana's production is industrial grade.[19] Gem diamond in the 2- to 4-carat range was recovered in a dredging operation by Dunkwa Goldfields Co. on the Jimi River in the Ashanti region. Small gem stones were also recovered in the Bonsa Valley of Western Ghana. The First International Natura Corp., New York, with substantial U.S. investment, negotiated with the Government of Ghana for mining rights on a 25-square-mile area at the confluence of the Birim and Pra Rivers. The Government will have 55% equity in the project when negotiations are concluded.

Diamond production is marketed exclusively by the Government's Diamond Marketing Corp. (DMC). DMC buys all local diamond production, and grades, values, processes, and sells to end users abroad. The sales of diamond abroad were made with the assistance of Consolidated African Selection Trust in London. The majority of diamond exports were made to the United Kingdom, the Netherlands, and Belgium-Luxembourg.

Israel.—The diamond industry in Israel was said to be the world's largest.[20] Exports of polished diamond in 1975 were 2,701,388 carats, compared with 2,467,008 in 1974, an increase of 9.5% according to statistics of the Diamond Department of the Ministry of Commerce and Industry. The contemporary market demand for smaller stones resulted in a 2.4% decrease in the value of 1975 exports, $548.6 million compared with the record $562.2 million in 1974. The U.S. market accounted for $153 million out of Israel's total 1975 exports. In concentrating on the smaller stones, it was estimated that in 1975 Israel produced 85% of the world's supply of melées (gem diamonds of from 40 stones per carat to 2 stones per carat). The wider application of automated equipment in many plants plus increased individual effort made possible greater output with approximately the same number of workers.

Lesotho.—After nearly 2 years of negotiations, Prime Minister Leabua Jonathan and De Beers Consolidated Chairman Harry Oppenheimer signed an agreement which will open a new diamond mine in Lesotho.[21] Control of the mine will be by a newly formed company, De Beers Lesotho Mining Co., Ltd., in which Lesotho will hold 25% equity. De Beers investment commitment is U.S. $35 million over 2 years.

The agreement permits development of Lesotho's only identified kimberlite diamond pipe at Letseng la Terae in the northeastern district of Mohkotlong. Output of the mine, will be marketed through a second company to be formed by De Beers and registered in Lesotho. Lesotho will charge a sales tax of about 15% on mine production until De Beers recovers its capital costs. Depending on the mine profitability, the taxes may rise to 71.5% of profits on a graduated scale.

[17] Bolsa Review. News Review. April 1975, p. 220.
[18] Omang, J. Emeralds a Way of Life in Colombia. Washington Post, Sept. 2, 1975, p. D10.
[19] Bureau of Mines. Diamond: Ghana. Mineral Trade Notes, v. 72, No. 4, April 1975, p. 14–15.
[20] Israel Industry & Commerce & Export News. Israel's Diamond Industry. V. 27, March 1976, p. 5.
[21] Bureau of Mines, Diamond: Lesotho. Mineral Trade Notes, v. 72, No. 4, April 1975, pp. 15–16.

Malagasy Republic.—The Malagasy Service of Mines reported production and export of a variety of gem and ornamental stones which contributed to the foreign exchange earnings of the Republic. The list included agate, amazonite, amethyst, beryl (gem grade), citrine, garnet (gem grade), opal, tourmaline, jasper, labradorite. rose quartz, and smoky quartz. The exports were mostly to collectors interested in minerals from the Island of Madagascar.

Pakistan.—The Pakistan Mineral Development Corp. recovered about 3,000 carats of rubies at the Hunza ruby mines for testing and evaluation in Karachi.[22]

Sierra Leone.—The 51% Government-owned National Diamond Mining Co. commenced prospecting in new areas of the Southern Province to replace diamond deposits nearing exhaustion. Diamond Distributors, International, Inc., of New York, acquired a prospecting license for diamond and gold.

South Africa, Republic of.—The Central Selling Organization reported diamond sales in 1975 of 793.5 million rands (US $1,066 million), or 6.5% less than in 1974.[23] During 1975, production exceeded sales, and the excess was absorbed into stock. No breakdown of either gem stones or industrial diamond sales was given. During 1975, demand for the smaller size of gem diamond improved, but the demand for larger, more expensive stones remained weak. To meet the demand for smaller stones, production at mines where the average stone size is smaller was increased and that of mines where the average is larger was decreased.

At the dormant Kimberly mine rains have caused severe slope failures in the drainage tunnel which was started in November 1975 and is expected to be completed in 1977. Also in the Kimberly Division, mechanization was accelerated to replace manual operations wherever possible in underground sections and on the surface under a program to phase out migratory labor.

South-West Africa, Territory of.—The Consolidated Diamond Mines of South West Africa (Proprietary) Ltd. reported an increase in ore treated in 1975 to 13,498,048 short tons from 13,047,780 tons in 1974. The average stone size decreased from 0.88 carat in 1974 to 0.73 carat in 1975. Overburden stripped increased from 45,074,540 tons in 1974 to 46,389,670 tons in 1975. Diamond production was higher in 1975 at 1,747,739 carats, compared with 1,569,961 carats in 1974.

The application of a well-point dewatering system together with the use of a bucket wheel excavator enabled mining to proceed up to 492 feet seaward of the high water mark, and extending operations to 656 feet appeared feasible.

U.S.S.R.—Soviet geologists, according to the Novost Information Service of Moscow, have discovered additional reserves of turquoise, other semiprecious stones, and industrial stones in Uzbekistan in Central Asia. The other stones included lazurite, chalcedony, onyx, quartz, and rhodonite. The Ministry of Geology added that a stone processing plant was already under construction to produce 322,920 square feet of ornamental stone tiles per year. Production of these stones in Uzbekistan will increase three or four times by 1980.[24]

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[22] Mining Journal. Industry in Action. Hunza Rubies Encouraging. V. 284, No. 7292, May 23, 1975, p. 403.

[23] De Beers Consolidated Mines Limited. 1975 Annual Report. 59 pp.

[24] Industrial Minerals. Company News & Mineral Notes. No. 93, June 1975, p. 51.

Table 3.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1973 Gem	1973 Industrial	1973 Total	1974 Gem	1974 Industrial	1974 Total	1975 p Gem	1975 p Industrial	1975 p Total
Africa:									
Angola	1,594	531	2,125	1,470	490	1,960	345	115	e 460
Botswana	362	2,054	2,416	408	2,310	2,718	362	2,052	2,414
Central Africa Republic	r 341	r 183	r 524	220	118	338	220	119	339
Ghana	r 231	r 2,076	r 2,307	257	2,315	2,572	233	2,095	2,328
Guinea e	25	55	80	25	55	80	25	55	80
Ivory Coast	120	180	300	112	167	279	84	125	209
Lesotho [2]	1	8	9	2	9	11	1	2	3
Liberia [3]	509	308	817	377	259	636	4 241	4 165	4 406
Sierra Leone	646	758	1,404	670	1,000	e 1,670	600	900	e 1,500
South Africa, Republic of:									
Premier mine	625	1,876	2,501	605	1,817	2,422	509	1,527	2,036
Other De Beers properties [5]	2,368	1,938	4,306	2,397	1,961	4,358	2,518	2,061	4,579
Other	455	303	758	438	292	730	408	272	680
Total	3,448	4,117	7,565	3,440	4,070	7,510	3,435	3,860	7,295
South-West Africa, Territory of	1,520	80	1,600	1,491	79	1,570	1,660	88	1,748
Tanzania	251	250	501	249	249	498	224	224	448
Zaire	r 1,082	11,858	12,940	1,143	12,468	13,611	1,076	11,734	12,810
Other areas:									
Brazil	r 56	r 57	r 113	127	127	254	135	135	e 270
Guyana	31	21	52	12	18	30	8	13	21
India	18	3	21	18	3	21	17	3	20
Indonesia e	12	3	15	12	3	15	12	3	15
U.S.S.R. e	1,900	7,600	9,500	1,900	7,600	9,500	1,950	7,750	9,700
Venezuela	315	463	778	279	970	1,249	239	821	1,060
World total	r 12,462	r 30,605	r 43,067	12,212	32,310	44,522	10,867	30,259	41,126

e Estimate. p Preliminary. r Revised.

1 Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Central African Republic (1973), Lesotho (1973–75), Liberia (1973–74), Guyana (1973), and Venezuela (all years), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

2 Exports of diamond originating in Lesotho; excludes stone imported for cutting and subsequently reexported.

3 Exports.

4 Partial figure, January 1 through December 15 only.

5 All company output from the Republic of South Africa except that credited to the Premier mine; excludes company output from the Territory of South-West Africa and Botswana.

TECHNOLOGY

Turquoise may be of inferior quality or may be confused with other materials to the disadvantage of the owner of the turquoise. For example, chrysocolla is identified frequently as turquoise. A simple test will help identify the sample correctly.[25] A drop of commercial grade of hydrochloric acid (HCl), commonly called muriatic acid (32% HCl), is placed on the sample. If it is chrysocolla, the acid will turn to a greenish-yellow color which can be easily observed by blotting it with a white tissue. No reaction will take place on fair to excellent quality turquoise. Azurite and malachite will change the acid's color and they will effervesce also.

American Indian turquoise jewelry can also be difficult to assess. Advice to prospective buyers included cautions against fakes, mass-produced or machine-made jewelry labeled "Indian" creation, and even stolen jewelry.[26] The quality of the turquoise in the jewelry was also described for the benefit of prospective buyers.[27] The geographical distribution of turquoise in

25 O'Haire, R. T. A Simple Test, Chrysocolla or Turquoise? Arizona Bureau of Mines, Fieldnotes, v. 5, No. 2, June 1975, p. 9.

26 Changing Times, The Kiplinger Magazine. The Big Rip-Off in Indian Jewelry. V. 29, No. 9, September 1975, p. 4.

27 Albuquerque Journal. Turquoise Cost Up, But Watch Out. 93d Year, No. 3, Apr. 21, 1974, pp. 1–2.

the United States is limited to the margins of the Colorado Plateau of the Southwestern States. With the aid of instrumental neutron activation analysis to detect trace elements, researchers are able to tell which turquoise came from which mine.[28] The information obtained from a study of turquoise artifacts from a pre-Columbian Indian village contributed knowledge to the trading patterns of the inhabitants.

The Job Safety & Health magazine of the U.S. Department of Labor indicated 10,000 lasers were in use by industry, and the boring of holes in diamond was noted.[29] A proposed safety code required protective housings, safety interlocks, visual and audible warning signals to alert operators in case of interlock failure and other steps to eliminate exposure to any radiation or other hazards.

The current process equipment and products of the semiconductor crystal industry were reviewed and predictions were made for the future state-of-the-art.[30] The processes which were described included the Czochvalski, float zone, pedestal growth, and zone leveling and procedures such as edge defined ribbon growth, dendritic web growth, Schmid Viechnicki, and cold crucible melting.

Natural diamond and most manufactured diamond are formed at high pressure. It is possible to synthesize diamond by growing it from existing diamond in a low-pressure gas rich in carbon.[31] It was found advantageous to have the seed diamond in powder form to take advantage of the large surface per unit of weight. Powder having a particle size of up to 1 micrometer has a specific surface of about 10 square meters per grain. It was also found that, if the diamond particles are suspended in the gas, such as methane by applied vibrations, the growth would be improved; the method could also yield threads, whiskers, or fibers of diamond.

Information about the earth's deep interior is scanty, and even inferences drawn from seismic and electrical conductivity measurements include assumptions about the relevant mineral species. Recently geophysical investigations applied improved techniques to suggest major revisions in the accepted hypothesis pertaining to the earth's lower mantle. The key to the new techniques is a device developed at the National Bureau of Standards and is known as a diamond-anvil or diamond-window pressure cell.[32] The device is not new, but its refinements and applications are. In addition to the work at the National Bureau of Standards, groups at the Geophysical Laboratory of the Carnegie Institution of Washington and at the University of Rochester contributed studies of chemical and physical properties.

The most prominent characteristic of minerals and gems is color. The cause of the color in many of these materials is frequently unknown or misunderstood, and many erroneous early guesses as to the causes of specific colors in minerals have been repeatedly copied from one text to the next so that much misinformation is current. Twelve distinct causes of color were described in three articles,[33] and brief outlines of four theories—crystal field, molecular orbital, band, and physical optics—were included.

The tumbling process has been in use about 30 years for polishing gem stones. The technique is more popular now than ever before, and an evaluation of tumbling was presented.[34] The shape of a tumbler may be round, hexagonal, or barrel. The material of construction may be glass, ceramic, plastic, rubber, or steel. The tumbler may have a fixed speed of rotation, or it may be variable. Tumblers may be open or sealed. Tumblers may rotate on a fixed or a variable axis, or may vibrate, usually on a vertical axis. The stones for the tumbler should be of similar grain, density, toughness, hardness, and porosity. The load should be exact, although most tumblers work well when about two-thirds to three-

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[28] Science News. Archaeology. Snaketown Turquoise Trading. V. 108, Nos. 8–9, Aug. 23–30, 1975, p. 125.

[29] American Metal Market. Laws for Lasers. V. 82, No. 13, Jan. 20, 1975, p. 26.

[30] Lenzing, J. Survey of Semiconductor Crystal-Growing Processes and Equipment. Solid State Technology, v. 18 No. 2, February 1975, pp. 34–39, 43.

[31] Devjaguin, B. V. and D. B. Fedoseev. The Synthesis of Diamond at Low Pressure. Scientific American, v. 233, No. 5, November 1975, pp. 102–109.

[32] Science. Research News. High-Pressure Geophysics: A Window on the Lower Mantle. V. 190, No. 4218, Dec. 5, 1975, pp. 967, 968.

[33] Nassau, K. The Origins of Color in Minerals and Gems—Part I. Lapidary J., v. 29, No. 5, August 1975, pp. 920, 922, 924, 926, 928.

——. The Origins of Color in Minerals and Gems—Part II. Lapidary J., v. 29, No. 6, September 1975, pp. 1060, 1062, 1064, 1066, 1068, 1070.

——. The Origins of Color in Minerals and Gems—Part III. Lapidary J., v. 29, No. 7, October 1975, pp. 1250, 1252, 1253, 1254, 1256, 1258.

[34] Zertner, J. C. Tumblers, Tumbling and Tumbled Gems—Part I. Lapidary J., v. 29, No. 9, December 1975, pp. 1670–1691.

fourths full. The amounts of fluid or water, abrasive polishing media, and special additives are also variable. Because of all the possible variations, it was recommended that the instructions of the manufacturers be followed explicitly.

Gold

By J. M. West [1]

Gold prices trended downward in 1975 from historic highs reached at the end of 1974. Nevertheless, the average price for the year was slightly above that of 1974 at $161.49 per troy ounce versus $159.74 a year earlier (Engelhard prices for unfabricated gold). The highest price for the year was $185.75 on February 24 and the lowest price $129.25 on September 23. London final prices ranged between $128.75 and $185.25, averaging $161.02. Major factors influencing prices were sales of Treasury gold in January and June 1975 and the announcement at the end of August 1975—after previous discussions but no decisions—by the International Monetary Fund (IMF) that a sixth of that organization's gold stocks would be sold to provide capital for low interest loans to developing countries. By yearend the domestic price of gold had recovered somewhat to $140.75, a result of uncertainties about the timing of IMF sales, about whether central banks would be allowed to purchase the gold, and even whether the sales would take place at all. Another factor in the price recovery was increasing demand for consumer gold products in the second half of the year. Futures trading of gold, initiated on December 31, 1974, in New York and Chicago, had a stabilizing influence on prices and provided a means for producer-consumer hedging and speculative trading. Sizable deliveries were made to consumers from exchange stocks in New York and Chicago depositories during 1975.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient gold statistics

	1971	1972	1973	1974	1975
United States:					
Mine production ---- thousand troy ounces --	1,495	1,450	1,176	1,127	1,052
Value ---------------------- thousands --	$61,673	$84,967	$115,000	$180,009	$169,928
Ore (dry and siliceous) produced:					
Gold ore -------- thousand short tons --	3,471	3,316	4,715	4,598	5,722
Gold-silver ore ------------------ do ----	167	173	124	65	137
Silver ore ------------------------ do ----	574	355	370	560	647
Percentage derived from:					
Dry and siliceous ores ------------------	60	58	52	58	62
Base-metal ores ------------------------	39	41	47	41	36
Placers ---------------------------------	1	1	1	1	2
Refinery production [1] thousand troy ounces --	1,437	1,478	1,210	1,021	1,093
Exports: [2]					
Commercial --------------------- do ----	1,278	766	601	570	2,689
Government --------------------- do ----	61	706	2,384	3,293	807
Total ------------------------- do ----	1,339	1,4[illegible]2	2,985	3,863	3,496
Imports, general [2] ------------------ do ----	7,201	6,126	3,845	2,651	2,662
Gold contained in imported coins ---- do ----	--	--	--	3,090	1,673
Sales from foreign stocks in Federal Reserve Bank -------------------- do ----	--	--	1,704	2,144	577
Stocks, Dec. 31:					
Monetary [3] ----------------- millions --	$10,206	$10,487	$11,652	$11,652	$11,599
Industrial [4] ---- thousand troy ounces --	4,375	4,407	4,498	5,670	788
Consumption in industry and the arts ----------------------------- do ----	6,933	7,285	6,729	4,651	3,993
Price: [5] Average per troy ounce ------------	$41.25	$58.60	$97.81	$159.74	$161.49

See footnotes at end of table.

Table 1.—Salient gold statistics—Continued

	1971	1972	1973	1974	1975
World:					
Production ---------- thousand troy ounces --	46,495	44,843	43,297	r 39,941	38,574
Official reserves [6] ---------------- millions --	$44,742	$45,000	$49,850	r $49,790	$49,740

r Revised.
[1] From domestic ores—U.S. Department of the Treasury, 1971–74, and Bureau of Mines, 1975.
[2] Excludes coins.
[3] Includes gold in Exchange Stabilization Fund.
[4] Gold content of all products in stocks held by manufacturers and refiners, 1971–74; gold content of bullion only in 1975 (excludes trading stocks). Stocks at beginning of 1975 amounted to 1,896,000 ounces of bullion.
[5] Engelhard Industries quotations.
[6] Held by market economy central banks and governments; gold valued at $38 per troy ounce in 1971–72, and $42.22 per ounce in 1973–75.

Again in 1975 U.S. markets were supplied with gold sold by foreign governments from stocks on deposit at the Federal Reserve Bank in New York. These sales totaled only 576,593 ounces compared with 2,144,000 ounces in 1974. Treasury sales supplied 1,253,500 ounces to domestic markets. Total gold imports amounted to 2.66 million ounces, slightly higher than in 1974, and exports totaled 3.50 million ounces, 10% lower than in 1974. Net bullion exports amounted to 0.75 million ounces. Exports were at a high in January and February. In addition to bullion and unrefined gold trade, coins estimated to contain 1.67 million ounces of fine gold were imported, down considerably from the 3.09 million ounces imported in 1974. Most coins were valued mainly for their bullion content and had small premiums for numismatic values. Supplies of gold amounting to 1,108,000 ounces came out of industry stocks, but the new futures trade exchanges absorbed an estimated 550,000 ounces in establishing the yearend 1975 stocks. Refining of old scrap contributed 1.12 million ounces to supplies (the balance of refined scrap is considered runaround scrap not affecting supply or demand). Mine production amounted to 1.05 million ounces, 7% lower than in 1974, and the Homestake mine in South Dakota continued as the top producer, accounting for 29% of total U.S. output. Nevada, however, became the first ranking State in gold production, followed by South Dakota, Utah, Arizona, and Colorado. The five States provided 92% of all mine production.

Domestic gold consumption continued the decline which began in the second half of 1972. During 1975 4.0 million ounces of bullion was consumed, 14% less than in 1974 and 45% less than the 1972 gold consumption.

Despite the manufacture of bullion products in a variety of forms for the investment market and extensive sales promotions, public demand failed to materialize for these items as an investment medium. After a brief flurry of sales at the beginning of the year, demand faded, partly satisfied instead by sales of imported gold coins. Later in the year coin sales began to lag and sales campaigns were mounted in several parts of the country to stimulate demand.

Trading volume on the major commodity exchanges was almost twice as high in the second half of the year as in the first half. Both the Commodity Exchange Inc. (COMEX), in New York, and the International Monetary Market (IMM), in Chicago, had volumes of about 36 million ounces for the year. Monthly trading volumes ranged from 0.89 to 4.65 million ounces on these exchanges.

For the fifth year in a row since the historic high of 47.5 million ounces in 1970, world gold production declined, reaching 38.6 million ounces in 1975. The Republic of South Africa, which supplied 68% of world production in 1970, was a source of 59% in 1975, with the U.S.S.R. increasing output to account for 19% in 1975. Canada remained the third ranking world producer in 1975 with 4% of the output, and the United States was fourth, with 3%.

Legislation and Government Programs.—Following the end of controls on the holding and trading of gold by U.S. citizens on December 31, 1974, the Department of the Treasury announced it would abolish the Office of Domestic Gold and Silver Operations, which had regulatory functions. The action was effective in mid-1975. Subsequently, for advisory purposes and to continue some of the functions, a Deputy Director of Gold Market Activities was established in the Office of Foreign Exchange Activities.

A revised list of charges was published for gold and silver assays by the Bureau of the Mint.[2] Ore sample assays were priced at $5 for gold or silver and $8 for both in one sample, the assays being made at the U.S. Mint, Denver, Colo. 80204. A notice was published terminating Treasury gold regulations and licensing functions.[3] Part 54 of the Federal Statutes, entitled Gold Regulations, was revoked in its entirety. The section of Treasury Rules and Regulations on gold coin and gold certificates (Title 31, Part 100, Sect. 100.4) was revised to read: Gold coins and gold certificates of the type issued before January 30, 1934, are exchangeable, as provided in this part, into other currency or coins which may be lawfully issued.

The U.S. Customs Service ruled that gold coins reproduced privately outside a government mint, or without official sanction, and imported into the United States, must be legibly marked in a conspicuous place to indicate the English name of the country of production. Such gold pieces were dutiable at the rate of 20% ad valorem. In addition, under the Hobby Protection Act, the unofficial pieces were required to bear the word "Copy," according to the Federal Trade Commission's Bureau of Consumer Protection.[4]

Congressional authority was granted to the American Revolution Bicentennial Administration and the U.S. Mint to produce three sizes of gold medals commemorating the Nation's Bicentennial. The gold was to come from U.S. Treasury reserves and the sizes, weights (in fine troy ounces content) and prices were as follows: 3-inch/ 13.18 ounce/ $4,000; 1-5/16-inch/ 1.167 ounce/ $400; and 29/32-inch/ 0.37 ounce/ $100.

The Treasury Department began a continuing program of gold sales through periodic offerings on an auction basis by the General Services Administration. Sales were held on January 6 when 754,000 ounces was sold at an average of $165.67 per ounce and June 30 when 499,500 ounces was sold at $166.05 per ounce. Further sales were anticipated by Treasury officials but none were scheduled during the remainder of the year. In August 1975 the sales were interrupted by the announced intention by IMF to sell 25 million ounces of its gold holdings at public auction. These plans were subject to further ratification in January 1976 when a time frame for the sales of about 4 years was established. Another 25 million ounces of gold was to be returned to the original donors. Meanwhile the possibility of further Treasury sales was reiterated. IMF had agreed at meetings in January and June 1975 to abolish the official price of gold. Further steps to abolish the official price were announced in January 1976, with a plan for monetary reforms.

On June 24 the Commodity Futures Trading Commission announced in the Federal Register regulations affecting trading in bullion and in gold and silver coins. The rules became effective as of the date of publication. Special attention was given to use of the mails in coin transactions.

Although it received no new funds for its program in 1975, the Office of Minerals Exploration, U.S. Geological Survey, retained authority to offer participatory loans for domestic gold exploration, with qualifying applicants eligible for up to 75% of approved costs. No new projects were funded in 1975.

DOMESTIC PRODUCTION

A drop in production at the Homestake gold mine, South Dakota, which, nevertheless, retained its position as the leading producer, and a continuing recession in the copper mining industry owing to low copper prices resulted in a 7% decline in U.S. gold production in 1975. Byproduct gold provided 36% of all gold produced in 1975 compared with 41% in 1974. Despite gradual phasing out of the Cortez gold mine operation, scheduled for closure in 1976, Nevada production rose 11%,

[2] Federal Register. Table of Charges and Regulations of the Mints and Assay Offices of the United States for Processing Silver and Assaying Bullion, Metals and Ores. V. 40, No. 73, Apr. 15, 1975, p. 16844.

[3] Federal Register. Gold Regulations and Gold Licensing Functions Procedures, and Forms: Termination. V. 40, No. 73, Apr. 15, 1975, p. 16844.

[4] Coin World. Coin Copies Face Tough Import Rules Under New Customs Service State. V. 16, No. 805, Sept. 17, 1975, p. 1.

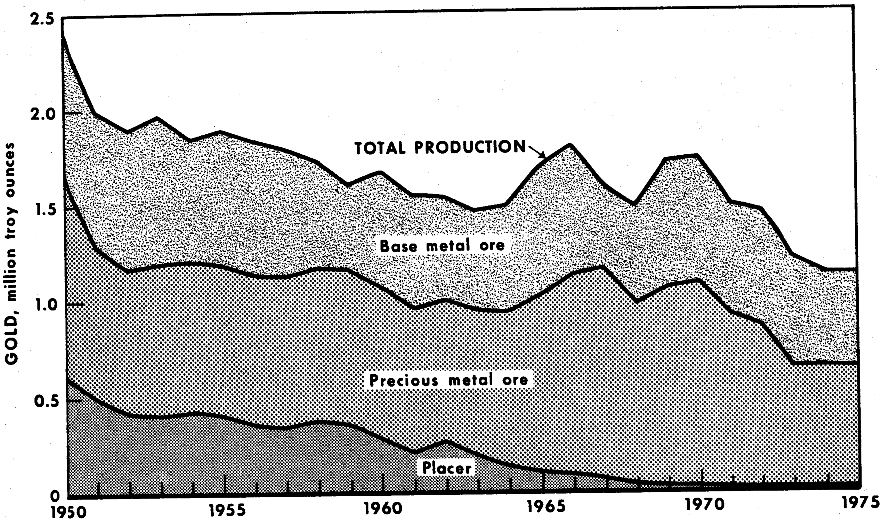

Figure 1.—Gold production in the United States by source.

mainly because of a 33% increase in output at the Carlin mine, the country's second leading gold producer in 1975. The third ranking producer was the Utah copper mine of Kennecott Copper Corp. Production was slightly lower in 1975 at the Knob Hill gold mine, Republic, Wash., and continued operations were doubtful owing to shortage of ore reserves. All Alaskan gold came from placer mining, the most significant new activity being at Nome where Alaska Gold Co. operated a rehabilitated bucketline dredge during the summer. The firm also continued dredging at Hogatza, in the Hughes district, north of Ruby, Alaska.

The four leading domestic producers accounted for 73% of total gold production in 1975; 95% came from the first 25 mines, 10 of which were operated mainly for gold or gold and silver. Placers contributed 2% of production. The number of placer mines reporting production rose to 49 from 43 in 1974. A portion of placer output continued to come from sand and gravel producers in California and Colorado where byproduct recovery units were maintained. A rehabilitated bucketline dredge came into operation at Hammonton, near Marysville, Calif., under the ownership of Yuba Goldfields, Inc., a new corporation, established to reopen dredging in an area last productive in 1968. A few thousand ounces was produced during the year. Standard Slag Co. opened the Atlanta gold mine, northeast of Pioche, Lincoln County, Nev., in early 1975 and produced by cyanidation at about the planned rate of 1,000 ounces per month.

Gold refiners reported production of 4.04 million ounces of refined bullion in 1975, 29% higher than in 1974, owing mainly to processing more scrap. Domestic ores and concentrates, including byproduct sludges, accounted for 27% of the output, and imported crude materials provided 6%. About two-thirds of production was from scrap, some of which was recycled several times during the year. Scrap refining activity was 40% higher than in 1974, partly because of efforts to reduce turnaround time and reduce inventory costs.

Gold refining operations at ASARCO Inc. east coast plants were phased down in 1975 in preparation for transfer of precious metal refining to a new plant at Amarillo, Tex. The new plant was expected to process less gold scrap than was formerly treated in the East. In early 1976 ASARCO announced the decision to discontinue refining at its Perth Amboy, N.J., plant. Gold refining at the Carteret, N.J., facilities of AMAX Inc., declined 14% in 1975 to 840,000 troy ounces. The company processes and refines gold mainly from scrap sources; some copper and other refinery sludges are also treated. Kennecott Copper Corp. refined 9% less ounces of gold than in 1974.

Homestake Mining Co. reported a 25% drop in income from the Homestake mine in South Dakota. A cave-in of a ventilation shaft and subsequent fire in the mine's exhaust air system reduced production. Gold bullion sales from the Homestake mine were valued at $55.16 million in 1975 compared with $47.93 million in 1974. The company's overall bullion sales were valued at $65.67 million compared with $59.80 million in 1974. Production totaled 304,877 ounces versus 343,650 ounces in 1974. The average recovered grade was 0.207 ounce per ton compared with 0.220 ounce per ton in 1974. A total of 1.47 million tons of ore was mined, 6% less than in 1974. Mill recovery was slightly higher in 1975 at 95.4% of the gold present in the ore. Ore reserves at the end of 1975 were reported at 15.26 million tons averaging 0.264 ounce per ton, mostly in proven and probable classifications. Efforts were directed toward developing additional ore in the 19 and 21 Ledges to compensate for declining reserves of high-grade Main Ledge ore. The lower grade 11 Ledge and marginal-grade upper level stopes contributed to lowered mill grade in 1975. Operating costs rose sharply in 1975 owing to higher labor and supply costs. Stope development was expanded and there were 105 active stopes at yearend. Development of blasthole stoping was expected to increase productivity. Construction was planned to start in early 1976 on the new $10 million Grizzly Gulch tailings dam and pumping system to handle mill wastes and reduce pollution in Whitewood Creek.

Gold production at the Carlin mine (includes the nearby Bootstrap and Blue Star mines) of the Carlin Gold Mining Co., owned by Newmont Mining Corp., in Eureka County, Nev., rose to 213,000 ounces compared with 160,500 ounces in 1974. Although the tonnage mined (ore and waste) declined 7%, the amount milled, 829,000 tons, was slightly greater and the ore grade at the mill was 0.292 ounce per ton, 31% higher than in 1974. Net income from the Carlin operation rose to $14.9 million compared with $10.9 million in 1974. The Bootstrap mine provided 57,000 tons of ore averaging 0.189 ounce per ton, and the Blue Star mine provided 51,500 tons averaging 0.147 ounce per ton. During 1975 stripping began of waste overlying 1.12 million tons of ore under the main Carlin pit. Substantial tonnages of highly carbonaceous ore requiring new metallurgical methods for treatment were reported at greater depth in the East Pit. Ore reserves were estimated at 5 million tons averaging 0.221 ounce per ton at the three mines, exclusive of the deep carbonaceous ore and about 0.5 million tons of 0.04-ounce-per-ton material at the Bootstrap and Blue Star properties.

Operations at the Cortez mine of Cortez Gold Mines in Lander County, Nev., were nearing an end, with ore reserves at both the main Cortez property and the nearby Gold Acres property almost exhausted. Leaching of ore in low-grade heaps was to continue until mid-1976, but milling was to terminate prior to that time. Average ore grade milled was down 30% in 1975 to 0.081 ounce per ton; 754,100 tons was milled, with recovery of 79% of the gold; 48,500 ounces of gold was produced by milling compared with 81,200 ounces in 1974, and 25,400 ounces was produced by leaching compared with 23,100 ounces in 1974. In addition, 14,300 ounces of silver was produced versus 17,200 ounces in 1974. Net earnings at Cortez in 1975 were $4.15 million compared with $9.3 million in 1974.

Production from the Gold Dollar lease of Day Mines, Inc. at Republic, Wash., was treated, together with other ores, by Knob Hill Mines, Inc., at its flotation-cyanide mill and amounted to 9,668 tons averaging 0.76 ounce per ton in gold and 3.42 ounces per ton in silver. Day Mines share of additional ores from the No. 3 joint operation (joint with Knob Hill Mines) was 7,253 tons averaging 0.3 ounce per ton in gold and 1.77 ounces per ton in silver. Reserves from these properties were expected to sustain two more years of production.

Alaska Gold Co. reported its No. 5 dredge operated for 117 days in 1975 near Nome, Alaska, handling 740,391 cubic yards of gravel and producing 7,791 ounces of gold. Operations began July 11, so only about two-thirds of the usual season was utilized. A second dredge, the No. 6, was being reequipped for another site near the airport at Nome. At Hogatza the company produced 3,360 ounces, operating from May 14 to October 17.

Golden Cycle Corp. reported an agreement to develop its properties at Cripple Creek, Colo., under a joint venture with Texasgulf Inc. Exploration conducted by Golden Cycle from 1972 through 1975 was said to have cost over $5 million. Smoky Valley Mining Co., a subsidiary of Copper Range Co., participating in a joint venture with Felmont Oil Corp. and Essex Royalty Corp., continued development of a large gold property at Round Mountain, Nev. First production was scheduled for late 1976 and the mine was expected to produce at a rate of 82,300 ounces per year for at least 5 years. Proven extractable ore reserves were estimated at 11.6 million tons averaging 0.06 ounce per ton. Open pit mining and heap leaching were planned. Facilities were reported half completed in 1975.

Azcon Corp. and Cyprus Mines Corp. joined in exploration projects at the Ortiz gold deposit near Cerrillos, N. Mex., where over 10 million tons of ore, grading about 0.05 ounce per ton was expected to be available to open pit mining, and at the Gold King mine, near Wenatchee, Wash, last operated in 1965. Ranchers Exploration & Development Corp. joined with Frontier Resources, Inc., and Marline Oil Corp. in exploring extensive gold-bearing placers in eastern Alaska. Drill results were being evaluated and reserves were believed to justify a mining operation.

CONSUMPTION AND USES

Domestic gold consumption, as measured by conversion of bullion into primary products, totaled 3.99 million ounces in 1975, 14% lower than in 1974. Consumption was divided, by estimated end use, as follows, in thousand ounces (with 1974 figures in parentheses): Jewelry and arts, 2,080 (2,402); dental, 595 (509); and in various industrial uses, mainly electronic, 1,059 (1,740). Jewelry and arts accounted for 52% of consumption; dental, 15%; industrial, 27%; and investment products, 6%. In addition to the usual consumption categories, gold was utilized in items for investment in 1975 for the first time following U.S. legalization of private ownership. A total of 258,000 ounces was reported consumed in the manufacture of fabricated bars and similar products designed mainly for investment buyers. About 45% of all gold consumption took place in the first half of the year. An estimated 66% of all gold went into karat gold products and bullion containing over 40% gold by weight; 16% was used in electroplated products, and the balance went into other forms of use such as rolled and gold-filled products.

U.S. buyers of gold products also purchased an estimated 1.7 million ounces of gold in the form of imported coins. This compared with the nearly 3.1 million ounces in coins imported for sale in 1974. Marketing of gold coins was at a slightly lower rate in the second half of 1975 than in the first half.

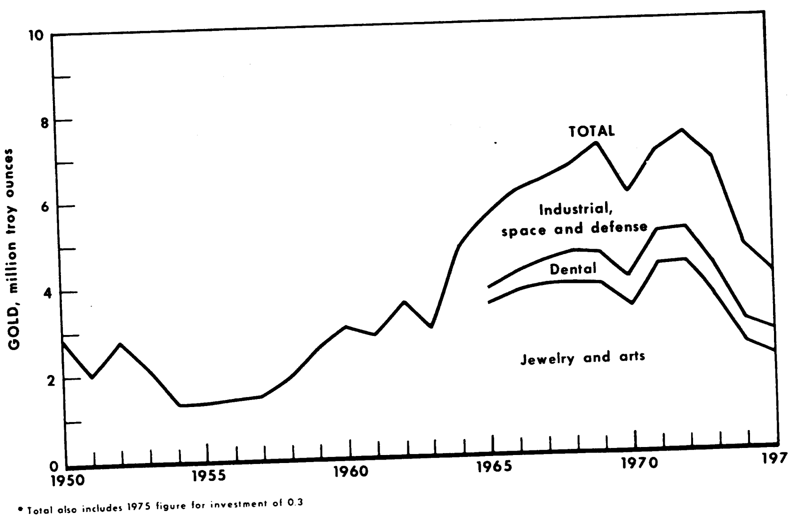

Figure 2.—Gold consumption in the United States.

Continuing high prices for gold in 1975 encouraged jewelry and electronic manufacturers to reduce the gold content of their products. Consumers tended to be receptive to products containing less gold where it could be demonstrated that performance and appearance were not significantly affected. Electroplaters were under pressure to reduce costs, and plating formulations were modified to use less gold while maintaining or even increasing performance qualities. Palladium was substituted for gold in switches by several companies, rhodium was considered for substitution in contacts and switches where extra durability was needed. Reflective surfaces were attained in plating by addition of small amounts of silver or, in a newer practice, about 0.2% of cobalt.

Inlay-clad gold and gold alloys were prominent in the design of electronic and electrical connectors as a reliable alternative to electroplated gold. Clad metal technology permitted thin coatings of varying composition and hardness down to a range of 1.25 to 5 micrometers, approximately the thickness of some electrodeposited golds. Cladding alloys included various combinations of gold, nickel, silver, copper, platinum, cadmium, and indium. An inlay-clad product is prepared by cutting a groove in a base metal strip and emplacing a precious metal strip which was previously bonded to a nickel strip. Rolling causes a bonding of the total strip. Use of clad gold for certain components in military applications was approved for the first time by the Defense Electronics Supply Center, and it was believed that since many specifications are based on military standards the move would greatly expand the use of clad gold.[5] Connectors in clad gold generally were priced 10% to 15% below the price of plated connectors.

Jewelry makers substituted silver for gold. One manufacturer used an alloy of half 14 karat gold and half sterling silver in wedding bands retailing at a 40% reduction in price.[6] Class rings were made of an alloy of silver, palladium, nickel, chromium, and other metals to simulate traditional white gold at a significant cost reduction. Substitution of silver for gold went a step farther than that, with the substitution of an aluminum-based alloy for a pewter-like product, which competes with silver products. Sales of heavy gold-plated and gold-filled products were reported higher in 1975 owing to the expense of karat gold products.

Gold can be applied to a variety of surfaces including aluminum and stainless steel, and as a result, an important potential use in solar heat collectors has been proposed. Gold-bearing heat absorbers have functioned at temperatures up to 400° C, and have proven easier to work with than alternative materials. In trapping solar energy, a coating of gold and manganese dioxide is used, taking advantage of wavelength differentials between solar and thermal radiation to enhance collection efficiency. In effect the thin gold coating provides a transparent heat mirror, trapping the solar energy. Gold films are applied by vacuum deposition or sputtering in such thin coatings that the price of the gold is considered unimportant to the product cost.

STOCKS

Monetary.—U.S. Treasury gold stocks at the beginning of 1975 amounted to 275.98 million ounces valued at $11,652 million and declined during the year as a result of gold sales in January and June to 274.73 million ounces valued at $11,599 million. Monetary gold stocks remained officially valued at $42.22 per fine troy ounce. Treasury gold sales, however, were at market-related prices.

Earmarked gold held in Federal Reserve banks for foreign official accounts was valued at $16,745 million at the end of 1975, equivalent to 396.61 million ounces, 2.20 million ounces less than at the end of 1974. Gold went partly to exports and partly to domestic markets.

Total gold reserves of all central banks and governments (excepting those of centrally planned economies) were valued by the Federal Reserve Bank at $49,740 million at the end of 1975, $50 million less than at the end of 1974. Major countries or institutions holding stocks, with equivalent million ounces, at the end of 1975

[5] Larsen, R. Promotion of Gold-Saving Process Seen in Military OK of Clad Gold Components. Am. Met. Market, v. 82, No. 63, Apr. 1, 1975, p. 7.

[6] Ward, A. All That Glitters Isn't Gold. Jeweler's Circ.-Keystone, March 1975, pp. 106–108.

were as follows: The United States, 274.7; IMF, 153.4; the Federal Republic of Germany, 117.6; France, 100.9; Switzerland, 83.2; Italy, 82.5; the Netherlands, 54.3; Belgium, 42.2; Portugal, 27.8; Canada, 22.0; Japan, 21.1; the United Kingdom, 21.0 (September); the Republic of South Africa, 17.7; and Spain, 14.3. World monetary stocks totaled 1,178.1 million troy ounces of gold compared with 1,179.3 million ounces at the end of 1974.

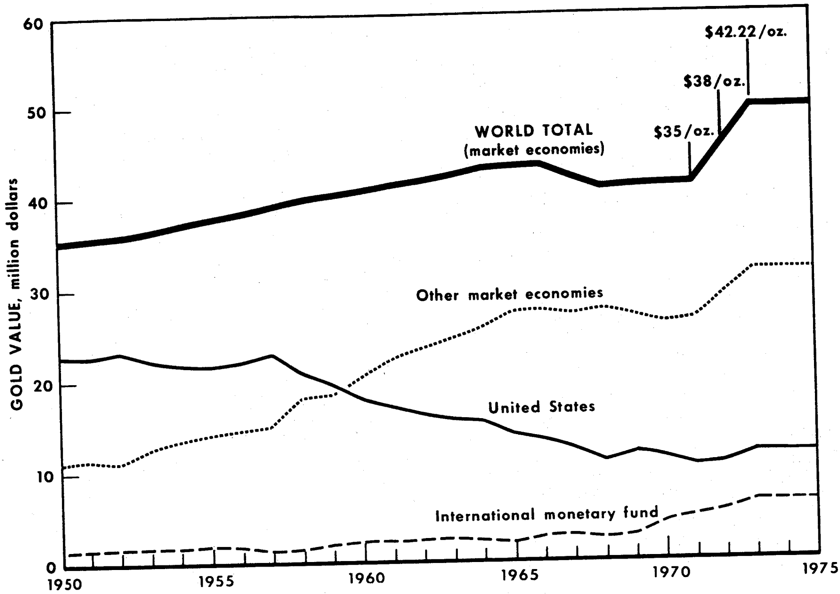

Figure 3.—World monetary gold stocks.

According to the IMF, world gold reserves in central banks (excluding international institutions and centrally planned economies) at yearend 1975 totaled 984.4 million ounces. Gold holdings were distributed in specified groupings (some overlap) as follows, in million ounces: Industrial countries, 824.3; other European countries, 50.8; Australia, New Zealand, the Republic of South Africa, 24.4; less developed areas, 85.0; oil exporting countries, 34.4; other Western Hemisphere countries, 17.2; other Middle East countries, 14.4; other Asian countries, 17.4; and other African countries, 1.6. The ratio of the value of gold reserves to overall money reserves reported for all countries was 1 to 5.48. Corresponding ratios by groupings were as follows: Industrial countries, 1:3.5; other European countries, 1:6.1; Australia, New Zealand, the Republic of South Africa, 1:4.8; less developed areas, 1:24.5; oil exporting countries, 1:40.0; other Western Hemisphere countries, 1:12.5; other Middle East countries, 1:8.7; other Asian countries, 1:17.7; and other African countries, 1:39.2.

Special Drawing Rights (SDR's) allocations, holdings, and quotas for all countries at the end of 1975 were, respectively, in millions: 9,314.8; 8,763.7; and 29,211.4. Each SDR was valued at an average rate of $1.21415 in 1975. Dollar values were based on changes in value of a "basket" of currencies of major trading countries. The U.S. gold position in the IMF was $2,212 million at the end of 1975 compared with $1,852 million a year earlier.

Industrial and Trading Stocks.—Data collected by the Bureau of Mines on industrial stocks of gold bullion 995 fine or better showed a drop of 1,108,000 ounces during 1975 to 788,000 ounces at yearend. Trading stocks which were estimated to amount to 550,000 ounces at yearend 1975, were held mainly by COMEX and IMM exchanges. Most of the same gold was registered to both exchanges, creating an overlap of data. Accumulation of trading stocks began shortly before the end of

1974 when firms began to prepare for gold trading. Gold placed in stocks had to meet grade specifications and other requirements. At yearend 1975 stocks registered and eligible to trading by COMEX were 403,237 ounces; stocks in the IMM totaled 531,421 ounces (includes all or most of COMEX stocks); and the Chicago Board of Trade held 19,097 ounces (partly also in IMM stocks). In addition there were minor stocks in the New York Mercantile Exchange and MidAmerica Commodity Exchange. The net result of declining industrial stocks and rising trade stocks was an estimated decline of 560,000 ounces in overall stocks.

PRICES

Gold prices, quoted daily by Engelhard Industries, began the year at $175.50 per troy ounce, rose to the high for the year of $185.75 on February 24, declined thereafter to the low of $129.25 on September 23, and ended the year at $140.75. Monthly averages showed a gradual decline from the high of $179.99 in February until August. From August to September the average dropped nearly $20, the fall attributed to an announcement on August 31, by the Interim Committee of IMF that there had been an agreement to sell 25 million ounces of gold at market related prices. From September to December prices gradually continued downward, with December averaging $139.80. The average for the year was $161.49 compared with $159.74 in 1974. London final prices were generally 50 cents less than Engelhard Industries prices, representing approximate transshipment costs, and averaged $161.02 in 1975. Through February 1976 there had been no announcement of a date for the pending IMF gold sales, and prices in early 1976 fluctuated close to $130. An official gold price of $42.22 per ounce remained in effect for valuing stocks of central banks; however, the IMF began action in 1975 to remove this official price, which it was said no longer appeared to serve a purpose.

Table 2.—U.S. monthly gold selling prices, per ounce

Month	1975		
	Average	Low	High
January	$176.77	$170.00	$180.75
February	179.99	173.90	185.75
March	178.58	176.75	182.35
April	170.34	164.50	177.75
May	167.89	164.00	175.25
June	164.74	162.25	166.75
July	165.71	163.00	168.90
August	163.45	160.30	167.25
September	144.07	129.25	153.75
October	143.26	139.40	146.75
November	143.27	139.75	146.40
December	139.80	137.75	142.90
Year	161.49	129.25	185.75

Source: Engelhard Industries.

FOREIGN TRADE

U.S. exports of gold in 1975 totaled 3.50 million ounces valued at $492.9 million. Of the amount exported, 807,138 ounces was monetary gold going to Singapore valued at the official rather than open market price. Exports of nonmonetary refined gold bullion amounted to 2.29 million ounces valued at $395.2 million. Destinations were mainly as follows, in million ounces: The United Kingdom, 1.34; West Germany, 0.42; Canada, 0.21; Switzerland, 0.17; and Mexico, 0.10. The balance of the gold exported consisted of scrap and base bullion amounting to 0.39 million ounces valued at $63.7 million, going mainly to Belgium (39%) and the United Kingdom (39%).

Imports of gold totaled 2.66 million ounces valued at $456.6 million and consisted of 0.31 million ounces of ore, scrap, and base bullion valued at $50 million and 2.35 million ounces of nonmonetary refined bullion valued at $406.6 million. Imports were 43% from Canada, 19% from Switzerland, 13% from the United Kingdom, 9% from France, and 16% from 40 other countries. Average valuations given for gold bullion imports from the leading sources, per troy ounce, were: Canada, $160.45; Switzerland, $184.95; the United Kingdom, $187.69; and France, $186.92. The overall average valuation was $173.09 per ounce. In addition to imports, gold markets were supplied with 0.58 million ounces of bullion from foreign government stocks stored at the Federal Reserve Bank in New York City.

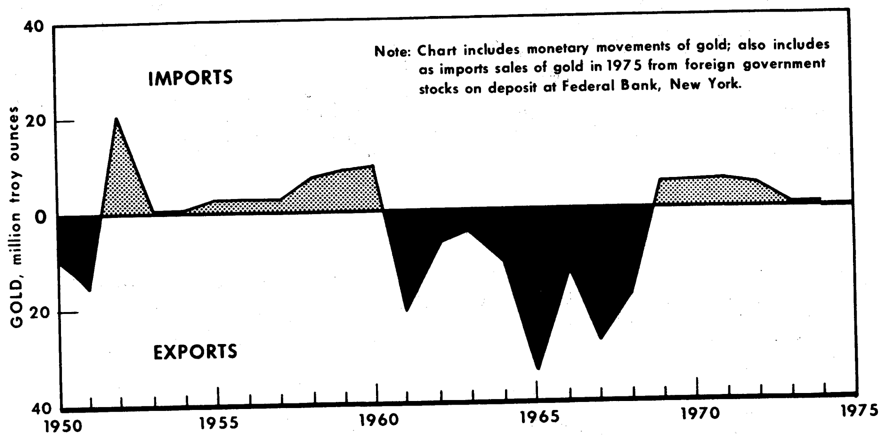

Figure 4.—Net exports or imports of gold.

The net inflow of gold to U.S. markets (excluding monetary movements but including supplies from foreign stocks in New York) amounted to 0.55 million ounces in 1975 compared with 4.23 million ounces in 1974. In addition an estimated 1.67 million ounces of gold was imported in the form of gold coins in 1975, 46% less than in 1974. Unrefined gold exports in the form of scrap and base bullion exceeded imports of ore, scrap, and base bullion by 81,000 ounces. The gold contained in the unrefined imports, amounting to 313,038 ounces, was 42% in ore and 58% in scrap and base bullion. Ores came from the Philippines (28%), Australia (25%), Canada (20%), Peru (13%), and 12 other countries (14%); scrap and base bullion came from Singapore (25%), Canada (22%), the Republic of South Africa (13%), West Germany (11%), and 30 other countries (29%).

WORLD REVIEW

A 3% drop in world gold production in 1975 was attributable mainly to continued declining production in the Republic of South Africa. Canadian and U.S. production also declined somewhat; significant increases were indicated in the U.S.S.R., up 3% according to estimates; in the Dominican Republic a new mine came into production. Copper production, an important source of byproduct gold in some countries, was lower in 1975 as a result of oversupply; thus, gold from byproduct producers was generally less than in 1974.

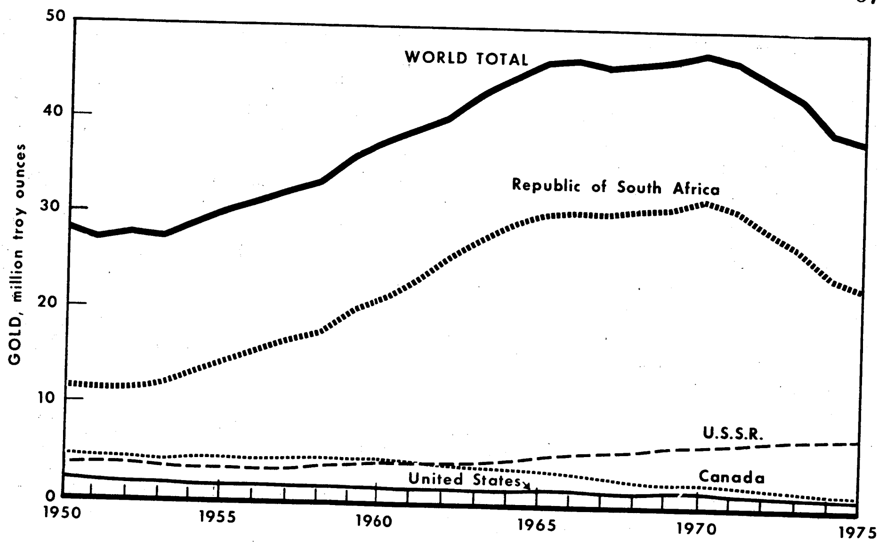

Figure 5.—World production of gold.

Consolidated Gold Fields Limited, in its annual world review, Gold 1976, estimated that the supply of gold to free markets fell 11% in 1975, and net bullion purchases for investment in 1975 amounted to 5.7 million ounces, one-fourth of the 1974 purchases for this purpose, indicative of a loss of investor interest in bullion. World gold demand for use in fabricated products showed a striking improvement in the second half of 1975, led by jewelry manufacture in developing countries. World supplies and net private purchases amounted to 36.2 million ounces, including 30.6 million from market economy country production, 4.8 million from centrally controlled economies, and 0.8 million from net official sales. It was estimated that 10% of production came from byproduct sources, mainly in the United States, Canada, the Philippines, and Papua-New Guinea. Net purchases (demand for gold) were broken down into the following categories (with 1974 figures for comparison in parentheses), in million ounces: Karat jewelry, 17.1 (7.4); electronics, 2.1 (3.1); dentistry, 2.1 (2.0); other industrial and decorative uses, 1.5 (1.9); medals, medallions, and counterfeit coins, 0.5 (0.2); official coins, 7.1 (9.2), and net private bullion purchases, 5.7 (16.7). Purchases for fabrication were also subdivided as follows, in million ounces: Developed countries, 22.0 (23.0); and developing countries, 8.5 (0.6). The leading countries in gold fabrication were, as follows with quantities in million ounces: The Republic of South Africa, 4.85 (mainly coinage); the United States, 3.82; Italy, 2.57; Japan, 2.42; West Germany, 1.82; Turkey, 1.77; the United Kingdom and Ireland, 1.49; Spain, 1.35; France, 1.10; Iran and Afghanistan, 0.90; and India, 0.84.

Gold used in official coins in 1975 was estimated to have increased 50% to 4.8 million ounces in the Republic of South Africa and 49% to 0.7 million ounces in the United Kingdom, but this use decreased 85% to 0.3 million ounces in Mexico, and 87% to 0.3 million ounces in Austria. Hungarian gold coinage dropped to nothing from 0.55 million ounces in 1974.

The Annual Bullion Review of Samuel Montagu & Co. Ltd. contained estimates of market supplies, as follows, in million ounces: New production, 30.2; U.S.S.R. sales, 4.5; and other sources, 2.9. Estimates of "offtake," also in million ounces, were: Europe, 14.8; the United States, 4.7; Far East, 5.1; Middle East, 3.2; rest of world, 2.7; investors, 7.1; for a total of 37.6. The total was 16% less than the estimate for 1974. Increases in gold jewelry purchases in the Far East and Middle East were notable during the year.

Following is a brief review of gold activities by country:

Australia.—Production declined in 1975 despite continued high gold prices. The Australia Industry Assistance Commission recommended phasing-out tax subsidies and concessions to gold mining and removal of restrictions on gold trading and on private ownership of gold. In early 1976 ownership restrictions were removed. Gold mining problems in Australia were discussed[7] and a report was published describing areas of gold occurrence in Australia.[8] A shortage of labor was evident in gold mining and costs were escalating. North Kalgurli Mines Ltd. suspended gold operations at Fimiston, Western Australia; Lake View and Star Ltd. stopped milling of custom ores at its plant. Western Mining Corp., operator of Gold Mines of Kalgoorlie (produced 87,394 ounces in the last half of 1974) considered closing its mines owing to higher costs and lack of government assistance. Western Mining conducted further exploration on the Queen Charlotte ore body and around the Kimbalda dome in Western Australia.

Newmont Proprietary Ltd. awarded Austin-Anderson (Australia) Pty. Ltd. a contract for construction of a $35 million open pit mine and milling facility at the Telfer gold deposit in the Paterson Range of Western Australia. Mining was planned to begin in 1977 at a rate of 1,200 tons per day. Reserves were estimated at 4.2 million tons averaging 0.28 ounce per ton. A 30% interest in the operation was acquired by Dampier Mining Co., Ltd., subsidiary of Broken Hill Pty. Co. Ltd. Inter Copper N.L. and Nobelex N.L. joined in developing the Lone Star gold and copper deposit at Tennant Creek in the Northern Territory. Also in the Northern Territory, Pancontinental Mining Ltd. and Getty Oil Development Ltd. began drilling the Jabiluka Two ore body where gold veins occur in the same area as uranium. Assays from a number of drillholes ranged from 0.2 to 5 ounces per ton over widths of 10 to 20 feet. At yearend Kalgoorlie Lake View Pty., Ltd., began closing its Fimiston gold mine, but signed a provisional agreement with Homestake Gold Ltd., subsidiary of Homestake Mining Co. (U.S.) for up to $8 million in financing for a 52% partnership to revive the gold operation.

Bénin (previously Dahomey).—New gold discoveries in Borgou Province of northernmost Bénin were reported as promising. Exploration was conducted by a group under the United Nations Office of Technical Cooperation.

Bolivia.—The Government called for foreign participation in a joint placer gold mining venture on the Kaka River, north of LaPaz. Values averaging 0.008 ounce of gold per cubic yard were reported in an area near Incahuara. South American Placers Inc. (U.S.) continued dredging gold on the Tipuani River and at the head of the Kaka River; upstream from the Tipuani dredges, El Camino Mines Ltd. (Canada) prepared to start placer operations in early 1976. A group of Bolivian companies test-drilled placer ground on the Upper Tuichi River.

Brazil.—Gold consumption in Brazilian industry was estimated at 0.51 million ounces in 1975, compared with production of about 0.25 million ounces. Owing to costs of importing gold, the Government attempted to encourage new gold production enterprises. A bucketline dredge was moved from the United States to Brazil in 1974 and was expected to be placed in service on a gold and diamond placer deposit of Dragagem Fluvial, S.A., partly owned by Hanna Mining Co. (U.S.). A potentially important gold lode discovery was reported in the Rondônia Territory near the Bolivian border. Gold Fields of South Africa Ltd. acquired stock in a Brazilian iron mining company, and the possibility was investigated to produce gold as a byproduct of iron mining at a new property.

British Solomon Islands.—On Guadalcanal, Solomon Islanders mined about 1,000 troy ounces of placer gold in 1975 at the Gold Ridge deposits.

Canada.—Canadian gold production declined about 1% in 1975, with lower outputs in Ontario, the Yukon, and British Columbia. Output by Province, in thousand ounces (with percent change from 1974 in parentheses), was Ontario, 747 (down 7%); Quebec, 433 (down 2%); Northwest Territories, 178 (down 3%); British Columbia, 155 (down 4%); Prairie Provinces, 67 (down 1%); Yukon, 21 (down 20%); and Atlantic Provinces, 20 (up 25%). Quartz lode and placer deposits contributed 75% of the total 1975 production and base metal mines the remainder. Placer mines accounted for less

[7] Australian Mining. Gold Mining Has Problems. V. 67, No. 7, July 1975, pp. 6, 9.
[8] Liddy, J. C. The Gold Potential of Australia. Australian Min., v. 67, No. 7, July 1975, pp. 17–33.

than 1% of production and were mainly active in the Yukon and British Columbia.

In Ontario Campbell Red Lake Mines Ltd. milled 222,196 tons of ore, producing 139,990 fine ounces of gold in the first 9 months of 1975 versus 219,861 tons and 146,547 ounces of gold in the comparable period of 1974. Operating costs rose to $24.52 per ton of ore treated compared with $19.18 per ton in 1974. Operating profits were down 4% as a result. Dickenson Mines Ltd. reported tonnage down 13% to 69,268 tons milled in the first 9 months of 1975, but gold production was up 4% to 27,597 ounces. In the same period, Robin Red Lake Mines Ltd. produced 18,623 ounces of gold from 27,956 tons of ore. Dickenson ore reserves were 343,500 tons averaging 0.475 ounce per ton and Robin Red Lake reserves were 87,600 tons averaging 0.721 ounce per ton at the end of September 1975.

Cochenour Willans Gold Mines Ltd. planned to close its Red Lake mining operations as a result of escalating costs. A few thousand tons of low-grade material was milled and drilling had outlined about 200,000 tons of ore averaging 0.22 ounce per ton. Also at Red Lake, the Abino Gold Mines Ltd. property was explored by Dickenson Mines and a significant ore discovery was reported from drilling offshore in the lake bottom. Three drills were operating at the property late in the year and ore tonnage was estimated at over 700,000 tons. Bulora Corp.'s Madsen mine at Red Lake operated at 400 tons per day and was believed to have at least 2 years' reserves. Eastwood Resources Ltd., controlled by Bulora, explored a promising gold-silver deposit, the Berens River mine, 120 miles north of Red Lake.

Rengold Mines Ltd. began milling gold ore at its Renabie mine near Missanabie, Ontario, beginning at 300 tons per day. Ore reserves were estimated at 303,000 tons averaging 0.224 ounce per ton and additional ore was inferred. A promising high-grade gold-silver discovery was also reported by Rengold about 5 miles southwest of the Renabie mine, and trenching was underway to expose the ore body for sampling. A potentially large gold deposit was discovered by Amoco Canada Petroleum Ltd. at Detour Lakes, 130 miles north of Kirkland Lake and a few miles west of the Quebec boundary in northeastern Ontario. By yearend 1975, 100,000 feet of core drilling was expected to be completed. Reserves on the order of 5 million tons or more averaging about 0.2 ounce per ton were estimated, based on partial results. The ore body, covered with 25 to 125 feet of overburden was discovered by geophysical surveys and followup drilling.

At Brampton, a few miles west of Toronto, Ontario, Johnson, Matthey & Mallory Ltd. was completing a new $5 million precious metals refinery, which was scheduled to open in April 1976.

In Quebec the new mine and mill of Agnico-Eagle Mines Ltd. produced at a rate of 900 to 1,000 tons per day by yearend 1975, after correcting initial milling problems, and expansion to 1,200 tons per day was underway. In the first half of the year 29,029 ounces of gold was produced from ores averaging 0.236 ounce per ton. Ore reserves were estimated at 2.6 million tons averaging 0.29 ounce per ton, promising 8 years of operation. Goldex Mines Ltd. had disappointing results on an 8,000-ton test run from its Dubuisson Township, Val d'Or area mine, but planned additional test shipments. East Malartic Mines Ltd. operated its mill at about 1,600 tons per day in 1975. Teck Corp. Ltd. reported a gold discovery at its property on the Bourlamaque Batholith, near Val d'Or. Camflo Mines, Limited having completed expansion of its mill from 1,000 to 1,250 tons per day, milled 342,578 tons in the first 9 months of 1975, producing 66,148 ounces of bullion. Average production costs were significantly higher than the $46.70 per ounce reported in 1974. Sigma Mines (Quebec) Ltd. milled 367,414 tons of ore in the first 9 months of 1975, producing 53,443 ounces of gold, and for the period, operating costs were $14.82 per ton versus $13.06 per ton for the corresponding period in 1974. Ore reserves were estimated at 1.25 million tons. Construction of a 1,000-ton-per-day cyanide gold mill was well along at Quebec Sturgeon River Mines Ltd.'s Bachelor Lake mines, where reserves totaled nearly 1 million tons averaging 0.195 ounce per ton. The company also was developing a gold property near Timmins, Ontario.

A number of companies were active in the Val d'Or-Noranda gold belt. Belmoral Mines Ltd. used geophysical instruments and drilling to outline an estimated 0.5

million tons of ore averaging 0.2 ounce per ton in Bourlamaque and Senneville Townships in the Val d'Or area. Thompson Bousquets Gold Mines Ltd. investigated a large low-grade gold property (2 million tons, 0.07 ounce per ton) in Bousquet Township and made a 15,000-ton test shipment to a custom mill. Pending higher gold prices, Noranda Mines Limited suspended its work at Dumagami Mines Ltd. in Bousquet Township where 2.5 million tons of ore averaging 0.095 ounce per ton was developed. Selco Mining Corp. continued exploration at its Detour mine in Brouillan Township northwestern Quebec, where 35.4 million tons of ore was estimated to contain 0.39% copper, 2.3% zinc, 1.04 ounces of silver per ton and 0.009 ounce of gold per ton. The Chibex gold mine, a new $13 million venture of Chibex Ltd. at Chibougamau, Quebec, was inoperative owing to poor metallurgical recovery—50% versus an expected 90%. Additional funds were sought to correct milling deficiencies.

In the Bathurst area of New Brunswick, Zarina Explorations Ltd. explored a rich gold-silver-lead deposit in the Millstream River area, 12 miles northeast of Bathurst. Claymore Resources reported rich placer gold results at its claims in the Gold Range district of the Yukon bordering Alaska, 250 miles northwest of Whitehorse. Drilling was continued at yearend. In British Columbia Caroline Mines Ltd. sought financing to develop its Ladner Creek property containing an estimated 1.5 million tons of gold ore averaging 0.14 ounce per ton. Feasibility studies on the project were to be completed by mid-1977. British Columbia passed a new Placer Mining Act effective June 2, 1975, making it easier to obtain placer mining rights. Placer mining was active at Atlin, British Columbia, and several locations nearby. Canex Placer Ltd. was expected to begin exploration of the Nevex Mines Ltd. Hag Group gold-copper property, 23 miles east of Osoyoos, British Columbia. Cominco, Ltd. began work on the second phase of a $17 million expansion of its Con gold mine at Yellowknife, in the Northwest Territories. Capacity was to be expanded from 450 to 1,100 tons of ore per day by the program. Ores generally graded 0.5 to 0.7 ounce per ton at the Con mine. Terra Mining and Exploration Ltd. negotiated for a production lease on gold properties at Buckham Lake, 53 miles southeast of Yellowknife, Northwest Territories.

Colombia.—The Government began paying market-related prices to gold producers for their output, spurring additional production. The Government also created a special loan fund for miners and assisted in financing Colombia's first gold reduction plant near Ibaque, central Colombia. Mine production was expected to reach 340,000 ounces in 1975, based on the first half-year results. The municipality of Condoto, Department of Chocó, refused permission to Mineros Colombianos, S.A., to dredge gold upstream from town, owing to possible environmental damage and displacement of a number of individual miners, who had questionable claims to the ground they were working.

Congo, Republic of.—A large gold discovery by a U.S.S.R. exploration team was reported at Kalmoueko, 250 miles north of Pointe Noire.

Costa Rica.—Hearne De Costa Rica, S.A., tested soil samples from its Miramar gold property, a former producer, and planned rehabilitation. Other properties, the Santa Clara and Mina Recio, were optioned to a Canadian firm, which conducted new exploration on several ore zones, one containing an indicated reserve of 750,000 tons averaging 0.1 ounce per ton available to open pit mining.

Dominican Republic.—Rosario Dominicana, S.A., began production in April at its Pueblo Viejo gold-silver mine and by yearend was operating at nearly full capacity (350,000 ounces of gold per year). The 1975 production totaled 195,941 ounces of gold and 109,465 ounces of silver from 1.7 million tons of ore grading 0.12 ounce of gold and 0.13 ounce of silver per ton. Developments were described in several publications.[9] Operating costs were expected to be $50 per ounce of gold. An increase in milling capacity from 8,000 to 10,000 tons of ore per day was under consideration. The company applied to the Government to convert the adjoining Los Cacaos exploration concession to a mining concession after developing a substantial tonnage of additional oxide gold-silver ore reserves. The Government, how-

[9] Argall, G. O., Jr. How Rosario Dominicana Discovered and Mines Microscopic Gold Ore. World Min., v. 28, No. 10, September 1975, pp. 36–42.
Brown, B. D. Columbus' Gold Mine Reopened By Rosario Resources. The Stock Market Magazine, v. 14, No. 7, August 1975, pp. 4–8.

ever, insisted on renegotiation of its agreements with Rosario and a decision was delayed.

El Salvador.—Bruneau Mining Corp., controlled by Rosario Resources Corporation, explored the El Dorado gold property, last operated about 1953. Extensive geochemical sampling was included. Canadian Javelin Ltd. reopened the Los Encuentros gold and silver mine, processing ores at the Minas San Cristobal mill and refinery. Output in 1975 was expected to reach about 75,000 tons averaging 0.09 ounce of gold and 5 ounces of silver per ton.

Ghana.—A new shaft was started at the Ashanti gold mine at Obuasi to provide an additional 55,000 ton-per-month hoisting capacity. The shaft is planned for 7,000 feet and is expected to handle 4 million tons during the estimated 15-year life of the mine.

Greece.—Greek Gold Mines S.A. and Masivor Corp. (Canada) began developing the first of three gold placer mines at Servia, Kozani. Proven reserves were estimated between 15 and 20 million cubic yards with values from 0.02 to 0.03 ounce per yard. A large additional yardage was inferred.

Hong Kong.—The Chinese Gold and Silver Exchange announced plans to invite overseas participation in trading and to convert to the troy ounce from the tael as a trade unit.

Honduras.—Gold mining possibilities in Honduras were assessed and a map of favorable areas was presented.[10] The Government approved a mining lease to Alianza Industrial, S.A., subsidiary of NRD Mining Ltd. (Canada), covering the Tatumbla open pit deposit containing an estimated 225,000 tons of ore grading 0.2 ounce in gold and 0.5 ounce in silver per ton. Rosario Resources Corporation planned to expand its El Mochito gold-silver mine output from 300,000 to 460,000 tons of ore per year by 1978.

Indonesia.—Recorded output of gold bullion was all from the State Mining Company, P.N. Aneka Tambang, and nearly all was from the Tjikotok gold-silver mine in West Java. Small amounts of placer gold were also produced by individual panners in Sumatra, Kalimantan, and northern Sulawesi. Indonesian law prohibited gold exports, and a 30% duty applied to imports, hence, smuggling was on the rise. Gold was also produced in copper concentrates from operations in West Irian, amounting to 53,158 ounces in 1974 and probably more in 1975. Concentrates containing about 0.25 ounce per ton in gold were exported to Japan for smelting and refining. New areas being explored for gold were in Logas, Central Sumatra; Northern Sulawesi; the Bengkulu area of West Sumatra; near Cianjur, West Java; in Kapuas, Central Kalimantan; at Gunung Mas, Central Kalimantan; and in the Mahakam Valley of East Kalimantan.

Mali.—The Mali Government signed an agreement with the U.S.S.R. for production of gold at the Kalna mine. Production on the order of 50,000 ounces per year was envisaged.

Mexico.—Four silver-gold mines in Guanajuato, being developed by Minera Las Torres S.A., were expected to produce at a rate of 50,000 ounces of gold annually in addition to 7 million ounces of silver beginning in 1976. A 2,000-ton-per-day mill was scheduled to begin operation in early 1976.

New Zealand.—The Kaniere gold dredge, operating on the west coast of New Zealand's South Island, produced 98% of the country's gold output.[11] It was planned to move the dredge to the Grey River soon when the current area is worked out.

Nicaragua.—Rosario Resources Corporation treated gold-silver ore by flotation at its Rosita property and stockpiled tailings for reprocessing when installation of a cyanide circuit was completed.

Pakistan.—A project was underway by the Pakistan Mineral Development Corp. to target gold placer areas for prospecting in the upper reaches of the Indus Valley. Tests on a large number of borehole samples were due for completion by yearend 1975.

Panama.—Tuquesa Mining, S.A., received a 15-year permit from the Government for exploitation of placer gold deposits in Darien Province. The company had completed a 5-year, $0.5 million exploration program, in which 150 million cubic yards of placer material averaging about $2 per yard were estimated to be available. The site is in a dense jungle accessible only by air. Negotiations were being conducted for purchase of suction

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[10] Svanholm, J. Gold in Honduras—Where to Look For and Find It. World Min., v. 28, No. 6, June 1975, 30–31, 61.

[11] Australian Mining. Gold Mining in N.Z. V. 67, No. 7, July 1975, pp. 39–40.

dredges and heavy mining equipment. Another large tract was opened for prospecting in the same region.

Peru.—Placer gold made up 31% of the 1974 gold production.

Philippines.—Gold production declined 6% to 501,776 ounces in 1975, with much of the drop late in the year. This was despite the reported entry of 7 new gold mines into operation adding to 11 existing ones. The Government offered a number of incentives to gold mining, and producers were allowed to sell gold to authorized dealers to obtain 100% loans to finance operations.[12] The Agusan gold mine was active,[13] and Atlas Consolidated Mining & Development Corp. planned to reopen the Masbate open pit gold mine at Rio Guinobatan, Masbate Island, reportedly having 6 million tons of reserves assaying 0.08 to 0.10 ounce per ton in gold.[14] The project was expected to cost about $10 million.

Consolidated Gold Fields Limited signed a contract for 40% participation in a gold project in Nueva Vizcaya, Luzon, where an estimated 16.5 million tons of low-grade ore will supply an output of 150,000 ounces of gold per year. Metals Exploration Asia Ltd. explored the Longos prospect in Paracale having estimated reserves of 600,000 tons averaging 0.55 ounce per ton and considered a 200,000-ton-per-year operation. Johnson Matthey & Co., Ltd. (U.K.) signed a contract with the Central Bank of the Philippines to supervise construction of a precious metals refinery at Quezon, east of Manila. Capacity of the plant will be 600,000 ounces of gold and 450,000 ounces of silver annually.

Rhodesia, Southern.—Rio Tinto (Rhodesia) Ltd. purchased the Renco gold-copper mine near Fort Victoria and on the basis of estimated underground reserves planned a 10-year mining venture. Grandeur Gold Mining Co. Ltd. planned to produce in 1976 after discovering gold at Grandeur Ranch Estates, 35 miles from Gatoona. Proven reserves were 182,000 tons averaging 0.25 ounce per ton; milling was planned at 3,000 tons per month.

Sierra Leone.—Renewed interest was indicated in Sierra Leone gold deposits, where placers were mined in the 1930's; a prospecting license was granted to Diamond Distributors, Inc. (U.S.).

Sikkim.—Sikkim Mining Ltd. reported discovery of a 2-million-ton deposit grading 0.32 ounce of gold and 2 ounces of silver per ton at the Kitchu copper property, between the eastern border of Nepal and southern Tibetan border. Construction of a smelter and refinery were considered.

South Africa, Republic of.—Gold production declined for the fifth consecutive year, down 6% compared with the 1974 output. Ore production totaled about 74.5 million tons, with grade averaging 9.51 grams per ton (0.28 ounce per short ton). The average grade was 30% below that of 1970, when gold prices began rising, while the tonnage mined was the same. Working costs rose sharply during 1975. At mines of the Anglo-American Group, costs rose 22% during the year ending in September 1975. A major factor was labor costs which rose nearly 40%.

A September devaluation in the South African rand, amounting to 17.9%, increased the rand payments to gold producers but made it more costly to import supplies and equipment needed from abroad. As a result of inflationary trends, working costs were expected to rise 15% to 25% in 1976. However, the supply of miners was expected to ease, with improvement in recruiting and a decline in labor disputes; the trends favored increased tonnages from many mines, although a further decline in the average ore grade was expected. Several mill expansion projects, due for completion in 1976, should add to tonnages treated.

The seven large gold producing groups reported the following outputs in 1975 (in million ounces, with 1974 outputs in parentheses): Anglo American Corp. of South Africa, Ltd., 9.16 (9.65); Gold Fields of South Africa Ltd., 4.34 (5.02); Rand Mines Ltd., 2.57 (2.80); Union Corp., 2.38 (2.51); General Mining & Finance Corp., 1.70 (1.86); Anglo Transvaal Consolidated Investment Co. Ltd., 1.38 (1.48); and Johannesburg Consolidated Investment Corp., 1.09 (0.96). The seven accounted for about 99% of South African gold production. A total of 39 gold mines was represented by these groups. Eight of the mines also reported production of uranium as a byproduct or coproduct. The largest of these was the

[12] Metal Bulletin. Philippines Gold Boost. No. 6020, Sept. 2, 1975, p. 25.

[13] Stewart, A. L. Agusan: Manila Mining's Au Mine and Cyanide Mill On Mindanao. World Min., v. 28, No. 5, May 1975, pp, 44–49.

[14] World Mining. Atlas To Reopen Masbate Gold Mine, Build New Mill. V. 28, No. 5, May 1975, p. 79.

Vaal Reefs, followed by the Harmony, Buffelsfontein, and Hartebeestfontein mines.

Three new mines were scheduled for production by 1981 or earlier. Union Corp. planned to open its Unisel mine on the Jurgenshof farm, Orange Free State, in September 1978. Using longwall stoping for mining, the property was to produce 75,000 tons per month, yielding 0.41 ounce per ton in gold. Ore reserves were estimated at 14.5 million tons. Gold Fields of South Africa planned to start production at its Deelkraal mine in 1980 and extract ore averaging 0.33 ounce per ton at a rate of 60,000 tons per month initially, increasing to 140,000 tons per month by 1983. By yearend two shafts had progressed to about 1,000 feet below the collars. Ore reserves were estimated at 45 million tons. At Anglo American Corp.'s Elandsrand mine, on the Buffelsdoorn farm northeast of the Deelkraal mine, initial shaft sinking reached depths of about 800 and 500 feet on two shafts, one for men and material and the other for ventilation and hoisting ore and rock. The mine was scheduled to begin production in 1981 and ultimately produce at a rate of 150,000 to 170,000 tons per month.

South Africa's proven ore reserves at the first of the year were reported at 287.7 million tons ("fully developed and blocked out") averaging 0.364 ounce of gold per ton. Exploration was accelerated in 1975 to the highest levels ever recorded. Over 500 surface and underground drills were operated and airborne geophysical surveys were conducted over many areas. Blyvooruitzicht Gold Mining Co., Ltd., reported finding rich intersections with the Main Reef in the western portion of its mine near the No. 2 shaft. Free State Saaiplaas Gold Mining Co. Ltd. began shaft sinking at its mine in the Orange Free State in a program to expand capacity from 1.2 to 2.4 million tons per year by 1979. The shaft was to go 7,380 feet deep. Also in the Orange Free State, Free State Geduld Mines Ltd. was expanding capacity from 200,000 to 237,000 tons per month. Randfontein Estates Gold Mining Co., Ltd., announced a major expansion to increase capacity from 73,000 to 250,000 tons per month by 1979. About half of the company's capital expenditures went into development in the Cooke section, with emphasis on completion of the No. 2 shaft. Expansion included provision for a new integrated gold and uranium facility. Freddies Consolidated Mines Ltd., upon being acquired by Free State Geduld Mines Ltd. of the Anglo American group, was to expand mill operations from 59,000 to 88,000 tons per month. Loraine Gold Mines Ltd. announced it would proceed with a $40 million expansion to raise its milling rate from 104,000 to 200,000 tons per month by 1979.

The Western Areas mine, which merged operations with the Elsburg mine in 1974, increased milling rates from 300,000 to 390,000 tons per month, was expanding its gold treatment units, and planned to begin sinking a third shaft in the Elsburg section. The East Driefontein mine was expected to reach capacity operation of 180,000 tons per month by the end of 1976.[15] Three reef systems were mined, the Ventersdorp Contact, the Carbon Leader, and the Main Reef, extending in the mine from 3,200 feet deep in the north to nearly 13,000 feet in the south. Quantities milled in 1975 totaled 1.46 million tons averaging 0.56 ounce per ton. Anglo American Corp. of South Africa, Ltd. planned a $115 million facility to retreat old mill tailings on the East Rand near Johannesburg to recover gold, pyrite, and uranium. The plant, to be commissioned in 1978, was scheduled to treat 1.5 million tons of tailings per month and to have an operating life of 20 years. Products would include annually 200,000 ounces of gold, 400,000 pounds of uranium oxide, 300,000 tons of sulfuric acid, and 140,000 tons of pyrite. Processing will involve flotation, roasting, acid treatment of uranium, and cyanidation of gold.

United Kingdom.—Beginning April 15, 1975, the British Government restricted the import of gold coins and medals to dealers only and prohibited the purchase of new gold coins by British citizens. Citizens were prohibited, also, under the new regulations from buying British-minted gold sovereigns having a 1974 date. The restrictions were imposed to stem the outflow of foreign exchange for gold.

U.S.S.R.—Gold sales to other countries were estimated by industry sources at 4.5 to 4.8 million ounces in 1975 compared with 7.1 to 7.3 million ounces in 1974.

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[15] Mining Magazine (London). East Driefontein Building Up to Capacity. V. 28, No. 5, May 1975, pp. 373–374.

The U.S.S.R. issued a 10-ruble gold coin called the Chervonetz, containing about 0.25 ounce of fine gold, and during the year produced about 250,000 units, of which an estimated 50,000 were shipped to the United States for sale. Soviet citizens were not allowed to own the coins, so the status as legal tender was questionable.

Zambia.—Gold production was scheduled to begin before yearend at the Luiri mine (formerly the Dunrobin), near Mumbwa, west of Lusaka. The mine was owned by Zambian Mindeco Small Mines Ltd.

TECHNOLOGY

Bureau of Mines research on gold recovery methods centered on leaching techniques as the best approach to extraction from low-grade ores. The Bureau's Reno Metallurgy Research Center assembled a trailer-mounted demonstration unit to perform field tests at active gold mines using newly developed methods of gold extraction. One method employed alkaline alcohol solutions to strip gold from the activated carbon used to collect gold from cyanide solutions.[16] Using a 10% to 20% methanol or ethanol additive to the conventional · hot caustic cyanide strip solutions achieved much more rapid and complete gold and silver removal. A patent was issued on the hot caustic method by which gold-loaded carbon is contacted with a solution of sodium hydroxide and sodium cyanide at temperatures of 150° C to 165° C to dissolve the gold.[17] Relatively small amounts of solution are required and the resulting concentration is high.

Also to be demonstrated in the Bureau's mobile unit is a new procedure for separating silver from gold solutions. By removing silver in a simple precipitation step, gold of much higher purity can be produced at the millsite. A sodium sulfide precipitation/carbon adsorption method was shown to be an effective means of recovering silver and gold separately from cyanide solutions. An important advantage was that the technique greatly reduces the amount of activated carbon required for processing solutions relatively rich in silver. The process was adopted on a commercial scale by the Toulon Milling and Mining Co. in Nevada.

Other work at the Reno station included successful application of an electrooxidation technique to treat a gold telluride concentrate containing 52 ounces of gold per ton. Gold extraction was 94.6% and the electrical energy consumption was 168 kilowatt hours per ton of concentrate. The technique was also applied to a carbonaceous ore containing 0.14 ounce of gold per ton, but achieved only about 50% extraction with similar energy applied. The cell used was airlift bipolar, with four electrodes suspended in a 30% pulp density-10% sodium chloride ore slurry. Electrolysis pretreatment of samples of carbonaceous gold ores from Montana using a larger flow-through cell showed a 7% to 18% increase in gold extraction over conventional cyanidation utilizing 23 to 56 kilowatt hours per ton. Work was also conducted at the Reno facility on extracting byproducts in black sands from placer gold mining operations in northern California.

The Salt Lake City Metallurgy Research Center worked with the Defense Disposal Agency, Ogden, Utah, and Battle Creek, Mich. to assist that agency in precious metal scrap handling. Electronic scrap was evaluated and analyzed. Some results, in ounces of gold per ton, were connectors, 7 to 374; circuit boards, 37; circuit frames, 149 (242 stripped).

Small scale carbon-in-pulp cyanidation tests, simulated heap leaching, and other amenability tests were conducted on ores from a number of mines in the Western States. A 97.3% overall recovery was achieved from one ore grading 0.35 ounce of gold per ton using the carbon-in-pulp method. Research on a refractory ore from the Mercur district in Utah showed that better recovery was obtained by cyaniding ore composites than was indicated by individual sample tests, apparently owing to interaction or better distribution of arsenic, carbon, and other impurities. The gold recovery was increased 10% or more; overall recovery, however, was only on the order of 80%, owing to problem ele-

[16] Fischer, D. D. Process for Recovering Adsorbed Gold and/or Silver From Activated Carbon. U.S. Patent applied for Ser. No. 559,941, filed Mar. 19, 1975.

[17] Ross, J. R. (assigned to Secretary of the Interior). Method of Desorbing Gold from Activated Carbon. U.S. Pat. 3,920,403, Nov. 18, 1975.

ments. Column cyanidation tests showed that two-thirds of the gold in a heap leach operation in California, with ore grading 0.07 ounce per ton and crushed to ½-inch size, could be extracted in about 30 days. Low-cost refining methods for gold and silver, adaptable to a small- to medium-size mine operation, were considered as a subject of new research.

Cyanide disposal problems were discussed at the September 1975 meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers at Salt Lake City, Utah. Titles of papers presented were as follows: Toxic Pollutant Effluent Standards; Description Rationale and Compliance Procedures; Design of Impoundment and Evaporation Ponds and Embankments for Cyanide and Other Toxic Effluents; the Chemical Basis of Techniques for the Decomposition and Removal of Cyanides; Chemical Oxidation of Cyanide Species by Ozone with Irradiation from Ultraviolet Light; and Cyanide Disposal at Homestake Mines. At the same meeting a report was given on the geology and geochemistry of the Getchell disseminated gold deposit, Humboldt County, Nev.

A successful heap leach gold cyanidation operation was established during the year at a New Mexico site near Albuquerque.[18] A list of major equipment and a cost summary were provided. Use of a fluidized bed reactor for roasting ore and special procedures with graphitic gold ores were described in a report on a large Canadian gold cyanidation and flotation mill.[19] Technical details on the construction and operation of a new gold mine and milling facility in the Dominican Republic were revealed.[20] The mill uses countercurrent decantation and has semiautogenous grinding, with capacity of 8,000 tons per day.

Advantages of the fire assay for gold and silver over other techniques of analysis were discussed, and procedures were described.[21] Reclamation of gold mine tailings was the subject of a report describing how to rehabilitate a tailings area.[22] Gold-dissolving bacteria, capable of dissolving up to 2.15 milligrams of gold per liter of solution in 2 to 3 months, have been discovered.[23] Gold was also recovered from an acid solution using mold fungi.

Equipment for high-capacity gravity separation, suitable for alluvial gold treatment, was described.[24] Testing of equipment was underway which would monitor particle size in milling at the Welkom mine, Orange Free State, Republic of South Africa, and which was expected to increase gold recovery about 0.4%.[25] Particle size control within 1% was said to be possible.

In mining, the Welkom mine was able to speed up underground tunneling, using jumbo drill rigs operating from both ends of a 1.3 mile haulageway, completing the work in 16 months.[26] At the Libanon gold mine, also in the Republic of South Africa, a full face tunnel boring machine was used for the first time to cut an 11-foot-diameter opening (raise borers had been used in raising since 1968).[27] An armored conveyor with integral blast screen, designed for use in a typical South African gold mine, was said to be capable of clearing blasted rock along a 130-foot face in 1 hour.[28]

A method of eliminating blasting in ore extraction from South African gold mines made some progress during the year. Several articles were published describing experimental machines which cut slots in a gold bearing quartz conglomerate "reef," reducing the amount of waste taken in mining the thin ore zone.[29] Boring of closely spaced holes along the reef as a means of extraction was another technique studied.

[18] Chisholm, E O. Junior Company Success Story: Canadians Operating Gold Leaching Operations in New Mexico. Northern Miner, v. 61, No. 27, September 1975, p. 59.

[19] Ramsay, E. Milling at Kerr Addison Mines Limited. Soc. Min. Engrs., AIME, Preprint No. 75-B-26, 1975, 7 pp.

[20] Sisselman, R. Rosario Dominicana Launches Latin America's Largest Gold Mine. Eng. and Min. J., v. 176, No. 10, October 1975, pp. 71–78.

[21] Williams, C. J., H. J. Seidemann, Jr., and R. E. Hawley. Precious Metal Assay: Is Fire Assay Here To Stay. Am. Lab., August 1975, pp. 63–69.

[22] Keller, H. and J. C. Leroy. The Systematic Reclamation of Gold Mine Tailings. Canad. Min. J., v. 96, No. 6, June 1975, pp. 45–46.

[23] World Mining. XI Mineral Processing Congress in Cagliari, Italy. V. 28, No. 7, July 1975, p. 48.

[24] Terrill, I. J., and J. B. Villar. Elements of High-Capacity Gravity Separation. Canad. Min. and Met. Bull., v. 68, No. 757, May 1975, pp. 94–111.

[25] Mining Journal (London). Methods & Machines: Monitoring Particle Size and Solids Content in Milling Gold Ores. V. 284, No. 7310, Sept. 26, 1975, p. 230.

[26] Canadian Mining and Metallurgical Bulletin. Welkom Gold Mine Sets Tunnelling Pace. V. 68, No. 757, May 1975, p. 119.

[27] World Mining. Gold Mines Try Tunnel Boring. V. 28, No. 5, May 1975, p. 89.

[28] Mining Magazine (London). Underground Mining: Gold Mine Armoured Conveyor. V. 132, No. 5, May 1975, pp. 397–398.

[29] Engineering and Mining Journal. Reef Slotting Rate in S. Africa Tripled By Radial Rock Slotter. V. 176, No. 4, April 1975, p. 37.

World Mining. Reef Cutting Breakthroughs Reported in South Africa. V. 28, No. 4, April 1975, pp. 48–51.

A new design for a movable shaft sinking head frame utilizing a "floating raft" was used at a South African gold mine.[30] Development plans, technical details, and cost breakdowns were given for the new Elandsrand mine, expected to come into operation in 1981 near Carletonville, South Africa.[31]

New evidence was developed appearing to confirm the role of well-differentiated Precambrian plant life in gold deposition in the Witwatersrand area of South Africa.[32] A series of excellent photographs document the evidence of bacteria, algae, fungi, and lichenlike plants associated with the gold. At a mine in Japan, conditions leading to deposition of gold in a typical epithermal deposit were established.[33] Gold was believed to be transported as gold-sulfur complexes rather than gold-chloride complexes and precipitation was mainly caused by an oxidation process.

A company in Providence, R.I., reported development of an ion exchange method using a coiled plastic tube filled with resins to extract gold, silver, rhodium, and other metals from plating solutions.[34] Improvements were described in flotation of pyrite containing gold values in South Africa.[35]

Patents were issued on processes of solvent extraction of gold using propylene or ethylene carbonate,[36] aqua regia separation of gold from platinum-group metals,[37] and production of high-purity gold powder from a cyanide plant precipitate.[38]

An evaluation was made of sources and processes for secondary precious metals recovery, and types of equipment used in smelting and refining were described.[39] The quarterly series of the Chamber of Mines of South Africa contained a variety of articles on new gold uses and technology.[40]

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[30] World Mining. Shaft Sinking Starts at Elandsrand Using New Movable Steel Headframe to Speed Work. V. 28, No. 4, April 1975, pp. 70–71.

[31] Mining Magazine (London). Elandsrand: South Africa's New Deep Level Gold Producer Takes Shape. V. 113, No. 5, November 1975, pp. 373–383.

[32] Hallbauer, D. K. The Plant Origin of the Witwatersrand "Carbon." Min. Sci. Eng. (Johannesburg), v. 7., No. 2, April 1975, pp. 111–131.

[33] Hattori, K. Geochemistry of Ore Deposition at the Yatani Lead-Zinc and Gold-Silver Deposit, Japan. Econ. Geol., v. 70, No. 4, June–July 1975, pp. 677–693.

[34] American Metal Market. Develop Metal Recovery System. V. 82, No. 199, Oct. 14, 1975, p. 15.

[35] Dekok, S. K. Gold Concentration By Flotation. J. South African Inst. of Min. and Met., Special Issue, v. 76, October 1975, pp. 139–141.
Chamber of Mines of South Africa Gold Bulletin. Gold Concentration by Flotation. V. 9, No. 1, January 1976, p. 19.

[36] Stephens, B. G. (assigned to W. M. Manning, Jr.). Solvent Extraction of Metals With a Cyclic Alkylene Carbonate. U.S. Pat. 3,912,801, Oct. 14, 1975.

[37] Pittie, W. H., G. Overbeek, and K. F. Doig (assigned to Swarsab Mining, Exploration, and Development Co. (Pty.) Ltd.). Separation and Purification of Gold. U.S. Pat. 3,929,469, Dec. 30, 1975.

[38] Bovey, H. J., D. A. Temple, and B. J. Goldswain (assigned to Anglo American Corp. of South Africa Ltd.). Producing High Purity Gold Powder. U.S. Pat. 3,930,845, Jan. 6, 1976.

[39] Wilson, B., and H. S. Roberts. Secondary Precious Metals Recovery. Met. Soc. of AIME Paper No. A-75-55, 1975. 13 pp.

[40] Chamber of Mines of South Africa Research Organization (Johannesburg). Gold Bulletin. V. 8, Nos. 1–4, 1975 issues (quarterly publication).

Table 3.—Mine production of recoverable gold in the United States, by State

(Troy ounces)

State	1971	1972	1973	1974	1975
Alaska	13,012	8,639	7,107	9,146	14,980
Arizona	94,038	102,996	102,848	90,586	85,790
California	2,966	3,974	3,647	5,049	9,606
Colorado	42,031	61,100	63,422	52,083	55,483
Idaho	3,596	2,884	2,696	2,898	2,529
Montana	15,613	23,725	27,806	28,268	17,259
Nevada	374,878	419,748	260,437	298,754	332,814
New Mexico	10,681	14,897	13,864	15,427	15,049
Oregon	244	W	W	W	W
South Dakota	513,427	407,430	357,575	343,723	304,935
Tennessee	192	176	68	18	W
Utah	368,996	362,413	307,080	254,909	189,620
Other States	55,434	41,961	29,200	26,025	24,187
Total	1,495,108	1,449,943	1,175,750	1,126,886	1,052,252

W Withheld to avoid disclosing individual company confidential data; included in "Other States."

Table 4.—Mine production of recoverable gold in the United States, by month
(Troy ounces)

Month	1974	1975
January	87,860	88,441
February	87,624	82,358
March	101,643	75,739
April	104,632	86,234
May	106,301	88,252
June	100,052	91,578
July	82,039	75,787
August	85,601	84,302
September	89,435	94,255
October	97,674	93,667
November	93,098	95,908
December	90,927	95,731
Total	1,126,886	1,052,252

Table 5.—Twenty-five leading gold-producing mines in the United States in 1975, in order of output

Rank	Mine	County and State	Operator	Source of gold
1	Homestake	Lawrence, S. Dak	Homestake Mining Co	Gold ore.
2	Carlin	Eureka, Nev	Carlin Gold Mining Co	Do.
3	Utah Copper	Salt Lake, Utah	Kennecott Copper Corp	Copper ore.
4	Cortez	Lander, Nev	Cortez Gold Mines	Gold ore.
5	Sunnyside	San Juan, Colo	Standard Metals Corp	Lead-zinc ore.
6	Knob Hill	Ferry, Wash	Knob Hill Mines, Inc	Gold ore.
7	San Manuel	Pinal, Ariz	Magma Copper Co	Copper ore.
8	Copper Canyon	Lander, Nev	Duval Corporation	Do.
9	Magma	Pinal, Ariz	Magma Copper Co	Do.
10	New Cornelia	Pima, Ariz	Phelps Dodge Corp	Copper, gold ores.
11	Ruth Pit	White Pine, Nev	Kennecott Copper Corp	Copper, gold-silver ores.
12	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Copper ore.
13	Leadville Unit	Lake, Colo	ASARCO Incorporated	Lead-zinc ore, lead-zinc cleanup.
14	Idarado	Ouray and San Miguel, Colo	Idarado Mining Co	Copper-lead-zinc ores.
15	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper, gold-silver ores.
16	Bootstrap	Elko, Nev	Carlin Gold Mining Co	Gold ore.
17	Nome Unit	Seward Peninsula, Alaska	Alaska Gold Company	Placer.
18	Continental	Grant, N. Mex	UV Industries, Inc	Copper ore.
19	Atlanta	Lincoln, Nev	Standard Slag Co	Gold ore.
20	Copper Queen	Cochise, Ariz	Phelps Dodge Corp	Copper ore.
21	Trixie	Utah, Utah	Kennecott Copper Corp	Gold-silver ore.
22	Pinto Valley	Gila, Ariz	Cities Service Company	Copper ore.
23	Hogatza River	Yukon River Region, Alaska	Alaska Gold Company	Placer.
24	Sacaton Unit	Pinal, Ariz	ASARCO Incorporated	Copper ore.
25	Gold Dredge Lisa	Yuba, Calif	Yuba Goldfields, Inc	Placer.

Table 6.—Production of gold in the United States in 1975, by State, type of mine and class of ore, yielding gold, in terms of recoverable metal

State	Placer (troy ounces of gold)	Lode					
		Gold ore		Gold-silver ore		Silver ore	
		Short tons	Troy ounces of gold	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold
Alaska	14,980	--	--	--	--	--	--
Arizona	--	308,485	2,664	21,658	28	--	--
California	4,860	23,696	3,833	W	W	--	--
Colorado	209	62,950	2,196	--	--	W	W
Idaho	--	2,566	276	96	9	520,215	659
Montana	146	526	207	21,448	2,967	71,455	546
Nevada	23	3,768,195	296,917	50,478	2,155	708	24
New Mexico	--	16,000	1,611	W	W	--	--
South Dakota	--	1,473,382	304,935	--	--	--	--
Other States [1]	25	66,002	24,085	43,330	6,369	79,763	212
Total	20,243	5,721,802	636,724	137,010	11,528	672,141	1,441
Percent of total gold	2	--	61	--	1	--	([2])

State	Lode					
	Copper ore		Lead ore		Zinc ore	
	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold
Alaska	--	--	--	--	--	--
Arizona	130,384,919	82,385	--	--	--	--
California	223	2	--	--	2,160	4
Colorado	3,690	223	900	38	177,494	367
Idaho	W	W	188,274	1,072	W	W
Montana	15,545,567	13,317	--	--	--	--
Nevada	6,822,922	33,288	250	1	800	138
New Mexico	19,401,491	12,634	--	--	W	W
South Dakota	--	--	--	--	--	--
Other States [1]	27,386,056	183,727	25	1	161,247	212
Total	199,544,868	325,576	189,449	1,112	341,701	721
Percent of total gold	--	31	--	([2])	--	([2])

State	Lode					
	Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores		Old tailings, etc.		Total [3]	
	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold	Short tons	Troy ounces of gold
Alaska	--	--	--	--	--	14,980
Arizona	94,834	385	65,759	328	130,875,655	85,790
California	--	--	W	W	29,199	9,606
Colorado	967,998	52,021	W	W	1,295,285	55,483
Idaho	1,013,724	466	--	--	1,759,152	2,529
Montana	81	19	605	57	15,639,682	17,259
Nevada	403,170	222	12	46	11,046,535	332,814
New Mexico	--	--	--	--	19,553,193	15,049
South Dakota	--	--	--	--	1,473,382	304,935
Other States [1]	2,230,783	881	2,491	[4] 482	29,714,345	213,807
Total	4,710,590	53,994	68,867	913	211,386,428	1,052,252
Percent of total gold	--	5	--	([2])	--	100

W Withheld to avoid disclosing individual company confidential data; included in "Other States."
[1] Includes Oregon, Tennessee, Utah, and Washington and items indicated by symbol W.
[2] Less than ½ unit.
[3] Data may not add to State totals due to items withheld to avoid disclosing individual company confidential data.
[4] Includes byproduct gold recovered from tungsten ore in California.

Table 7.—Gold produced in the United States from ore, old tailings, etc, in 1975, by State and method of recovery, in terms of recoverable metal

State	Total ore, old tailings, etc., treated [1] (thousand short tons)	Ore and old tailings to mills: Thousand short tons [1]	Recoverable in bullion: Amalgamation (troy ounces)	Recoverable in bullion: Cyanidation (troy ounces)	Concentrates smelted and recoverable metal: Concentrates (short tons)	Concentrates smelted and recoverable metal: Troy ounces	Crude ore, old tailings, etc., to smelters [1]: Thousand short tons	Crude ore, old tailings, etc., to smelters [1]: Troy ounces
Arizona	[2]169,245	[2]168,788	--	2,591	2,747,026	77,788	457	5,411
California	[3]29	[3]28	999	29	2,858	3,480	1	238
Colorado	[2]1,400	[2]1,396	12,324	1,398	154,207	41,113	4	439
Idaho	1,936	1,933	--	--	164,303	2,268	3	261
Montana	19,380	19,262	--	--	297,177	13,356	118	3,757
Nevada	[2,4]21,712	[2,4]21,661	427	298,099	374,414	33,689	51	576
New Mexico	[2]19,586	[2]19,513	--	1,611	661,104	12,833	73	605
South Dakota	1,473	1,473	--	304,935	--	--	--	--
Utah	27,752	27,609	--	--	637,750	184,025	143	5,595
Other States [5]	5,116	5,110	33	8,667	238,748	14,605	6	857
Total	267,629	266,773	13,783	617,330	5,277,587	383,157	856	17,739

[1] Includes some nongold-bearing ores not separable.
[2] Includes tonnages from which gold is heap leached.
[3] Excludes tonnage of tungsten ore from which gold was recovered as a byproduct.
[4] Includes tonnages from which gold is vat leached.
[5] Includes Oregon, Tennessee, and Washington.

Table 8.—Gold produced at amalgamation and cyanidation mills in the United States and percentage of gold recoverable from all sources

Year	Bullion and precipitates recoverable (troy ounces): Amalgamation	Bullion and precipitates recoverable (troy ounces): Cyanidation	Gold recoverable from all sources (percent): Amalgamation	Cyanidation	Smelting [1]	Placers
1971	3,071	832,463	0.2	55.7	43.0	1.1
1972	3,999	792,364	.3	54.6	44.2	.9
1973	15,381	583,311	1.3	49.6	48.1	1.0
1974	11,749	618,137	1.0	54.9	43.0	1.1
1975	13,783	617,330	1.3	58.7	38.1	1.9

[1] Crude ores and concentrates.

Table 9.—Gold production at placer mines in the United States, by method of recovery

Method and year	Mines producing	Washing plants	Material washed (thousand cubic yards)	Gold recoverable: Thousand troy ounces	Gold recoverable: Value (thousands)	Gold recoverable: Average value per cubic yard
Bucketline dredging:						
1973	2	2	[1]649	4	$402	$0.619
1974	2	2	[1]656	5	877	1.336
1975	4	5	[1]2,715	14	2,314	.852
Dragline dredging:						
1973	3	3	[2]55	[3]1	115	r [4]1.055
1974	1	1	13	1	131	9.984
1975	6	6	210	3	469	2.229
Hydraulicking:						
1973	12	12	245	2	167	.682
1974	16	16	223	2	381	1.710
1975	16	17	131	1	171	1.302
Nonfloating washing plants:						
1973	34	34	[2]32	[3]5	454	r [4]1.906
1974	14	14	[2]2	[3]3	461	r [4]3.000
1975	11	11	([2])	[3]2	269	([4])

See footnotes at end of table.

Table 9.—Gold production at placer mines in the United States, by method of recovery—Continued

Method and year	Mines producing	Washing plants	Material washed (thousand cubic yards)	Gold recoverable: Thousand troy ounces	Gold recoverable: Value (thousands)	Gold recoverable: Average value per cubic yard
Underground placer, small-scale mechanical and hand methods, and suction dredge:						
1973	20	3	19	(5)	$43	$2.263
1974	10	5	105	1	126	1.203
1975	12	8	27	(5)	47	1.752
Total placers:						
1973	71	54	[1 2]1,000	[3]12	1,181	[r 4].731
1974	43	38	[1 2]999	[3]12	1,976	[r 4]1.523
1975	49	47	[1 2]3,083	[3]20	[6]3,269	[4].973

[1] Does not include platinum-bearing material from which byproduct gold was recovered.
[2] Excludes tonnage of material treated at commercial sand and gravel operations recovering byproduct gold.
[3] Includes gold recovered at commercial sand and gravel operations recovering byproduct gold.
[4] Gold recovered as a byproduct at sand and gravel operations not used in calculating average value per cubic yard.
[5] Less than ½ unit.
[6] Data do not add to total shown because of independent rounding.

Table 10.—U.S. refinery production of gold
(Thousand troy ounces)

Source	1971	1972	1973	1974	1975
Concentrates and ores: [1]					
Domestic	1,437	1,478	1,210	1,021	1,093
Foreign	119	125	112	185	250
Old scrap	} 2,202	2,107	1,779	1,926	1,122
New scrap					1,574
Total production	3,758	3,710	3,101	3,132	4,039

[1] Includes other primary sources.

Source: 1971–74, Office of Domestic Gold and Silver Operations, U.S. Department of the Treasury; 1975, Bureau of Mines, U.S. Department of the Interior.

Table 11.—U.S. consumption of gold by end use
(Thousand troy ounces)

End use [1]	1971	1972	1973	1974	1975
Jewelry and arts:					
Karat gold	NA	NA	NA	NA	1,747
Fine gold for electroplating	NA	NA	NA	NA	31
Gold filled and other	NA	NA	NA	NA	302
Total	4,299	4,344	3,473	2,402	2,080
Dental	750	750	679	509	595
Industrial:					
Karat gold	NA	NA	NA	NA	39
Fine gold for electroplating	NA	NA	NA	NA	[2]592
Gold filled and other	NA	NA	NA	NA	428
Total	1,884	2,191	2,577	1,740	1,059
Investment [3]	--	--	--	--	258
Total consumption	6,933	7,285	6,729	4,651	[4]3,993

NA Not available.
[1] As reported by converters of refined gold.
[2] Figure as reported; however, 15% to 20% of this is estimated to go into jewelry as an end product.
[3] Fabricated bars, medallions, coins, and other products primarily for investment.
[4] Data do not add to total shown because of independent rounding.

Source: 1971–74, Office of Domestic Gold and Silver Operations, U.S. Department of the Treasury; 1975, Bureau of Mines, U.S. Department of the Interior.

Table 12.—U.S. exports of gold in 1975, by country

Destination	Ore, base bullion and scrap		Refined bullion	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Argentina	--	--	4	$1
Belgium-Luxembourg	155,506	$24,855	--	--
Brazil	--	--	39,695	6,231
Canada	28,111	4,456	206,989	36,319
Germany, West	16,003	2,718	422,785	70,093
Greece	--	--	321	53
Hong Kong	--	--	3,874	631
Italy	--	--	399	66
Japan	40,305	6,421	5,050	886
Lebanon	--	--	2,640	582
Mexico	--	--	103,789	18,375
Panama	--	--	27	5
Singapore	11	2	807,138	34,079
Switzerland	825	121	166,875	27,675
United Kingdom	153,209	25,081	1,341,832	234,214
Venezuela	--	--	394	68
Total	393,970	63,654	3,101,812	429,278

Table 13.—U.S. imports (general) of gold in 1975, by country

Country	Ore and base bullion and scrap		Refined bullion	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Argentina	21	$3	16,444	$2,564
Australia	32,749	5,290	600	85
Austria	--	--	19,992	3,719
Bahamas	3	1	--	--
Belgium-Luxembourg	3	(1)	804	143
Brazil	150	25	5,580	872
Canada	66,271	10,679	1,068,129	171,385
Chile	433	66	--	--
China, People's Republic of	2,235	365	499	88
Colombia	369	59	--	--
Costa Rica	493	34	--	--
Dominican Republic	9,855	601	--	--
El Salvador	142	21	--	--
France	--	--	246,158	46,011
Germany, West	19,995	4,030	14,914	2,714
Guatemala	219	8	--	--
Guyana	126	18	--	--
Honduras	2,216	262	--	--
Hong Kong	2,113	342	8	1
Indonesia	2	(1)	--	--
Israel	8	1	--	--
Japan	--	--	55,279	9,515
Korea, Republic of	1,483	145	--	--
Malaysia	2,234	322	--	--
Mexico	6,058	805	777	122
Netherlands	33	3	16,106	2,986
Netherlands Antilles	357	18	66	11
Nicaragua	15,341	2,393	162	20
Norway	4,259	740	--	--
Panama	5,755	628	1,543	112
Paraguay	--	--	1,597	262
Peru	20,422	3,232	--	--
Philippines	37,482	6,208	--	--
Singapore	44,582	7,401	57	9
South Africa, Republic of	26,487	4,995	4,038	627
South West Africa	2,824	480	--	--
Sweden	8	1	--	--
Switzerland	892	171	495,124	91,574
U.S.S.R	1,105	209	3,223	562
United Kingdom	2,838	418	347,715	65,263
Uruguay	--	--	4,153	605
Venezuela	3,475	81	1,590	257
Vietnam, South	--	--	20	3
Yugoslavia	--	--	44,358	7,073
Total	313,038	50,055	2,348,936	406,583

[1] Less than ½ unit.

Table 14.—Value of gold imported into and exported from the United States
(Thousand dollars)

Year	Exports	Imports
1973	145,965	356,150
1974	228,480	396,680
1975	492,932	456,638

Table 15.—Gold: World production,[1] by country
(Troy ounces)

Country [2]	1973	1974	1975 [p]
North America:			
Canada	1,954,340	1,698,392	1,674,000
Costa Rica	15,500	18,000	[e] 18,000
Dominican Republic	--	--	195,488
El Salvador	[3] 5,233	[3] 6,022	[e] 6,000
Honduras	795	2,124	[e] 2,000
Mexico	132,557	134,454	[4] 132,236
Nicaragua	85,051	82,639	70,281
United States	1,175,750	1,126,886	1,052,252
South America:			
Bolivia	35,964	41,600	53,242
Brazil	[r] 223,319	245,290	[e] 250,000
Chile	97,995	[3] 118,829	[3] 130,651
Colombia	215,876	265,195	299,366
Ecuador	10,420	7,752	[e] 8,000
French Guiana	1,350	1,125	[e] 1,000
Guyana	7,551	12,200	18,067
Peru	104,490	101,661	86,900
Surinam	96	406	[e] 500
Venezuela	19,105	[3] 17,023	[3] 18,326
Europe:			
Finland	19,773	20,737	22,216
France	[4] 55,235	40,542	49,866
Germany, West	2,087	1,315	2,108
Portugal	[r] 14,661	11,478	10,892
Romania [e]	60,000	60,000	60,000
Spain	278	223	[e] 200
Sweden	80,923	68,352	[e] 70,000
U.S.S.R.[e]	7,100,000	7,300,000	7,500,000
Yugoslavia	176,347	[e] 177,000	[e] 161,000
Africa:			
Angola	[e] 2,000	2,000	[e] 1,000
Cameroon	[3] 83	[3] 64	[3e] 960
Central African Republic [e]	64	64	529
Congo, Republic of the	1,254	707	[e] 800
Ethiopia	19,575	15,754	21,132
Gabon	[r] 11,221	7,298	4
Ghana	[3] 722,531	[3] 566,617	[3] 523,889
Guinea [e]	4,000	4,000	--
Kenya	[3] 136	235	108
Liberia	4	100	4,501
Mali [e]	30	--	--
Malagasy Republic	71	77	158
Mauritania [e]	56,000	52,000	42,000
Nigeria	[4] 21	113	[e] 100
Rhodesia, Southern [e]	[r] 800,000	[r] 800,000	800,000
South Africa, Republic of	27,494,603	24,388,203	22,937,820
Sudan	49	309	[e] 300
Tanzania	[4r] 55	[4] 42	[4] 78
Zaire	[r] 133,642	[3] 130,603	[3] 103,217
Zambia	1,608	5,755	4,823
Asia:			
China, People's Republic of [e]	50,000	50,000	50,000
India	[4] 105,390	[4] 101,114	91,437
Indonesia	[r] 43,957	76,491	[e] 73,000
Japan [5]	[r] 188,274	139,727	143,489
Khmer Republic [e]	4,000	4,000	500
Korea, North [e]	160,000	160,000	160,000
Korea, Republic of	[4] 16,268	[4] 23,792	[3] 13,343
Malaysia:			
Malaya	2,730	3,495	3,589
Sarawak	[r] 778	848	--

See footnotes at end of table.

Table 15.—Gold: World production,[1] by country—Continued
(Troy ounces)

Country [2]	1973	1974	1975 [p]
Asia—Continued			
Philippines	[r] 572,250	[5] 536,338	[3] 501,776
Taiwan	22,197	22,853	[4] 22,110
Oceania:			
Australia	554,278	522,127	[e] 514,186
British Solomon Islands Protectorate	[r] 963	873	[e] 800
Fiji	79,983	68,890	68,744
New Zealand	[3] 11,044	[3] 4,710	[e] 5,000
Papua New Guinea [6]	[e] 643,000	692,636	592,178
Total	43,296,755	39,941,080	38,574,162

[e] Estimate. [p] Preliminary. [r] Revised.
[1] Unless otherwise indicated, production is on the basis of mine output.
[2] Gold is also produced in Bulgaria and Czechoslovakia, and probably in small quantities in Argentina, Panama, Burma, East Germany, Hungary, Thailand, and several other countries. However, available data are insufficient to make reliable output estimates. Data are lacking on clandestine activities.
[3] Figure reported as fine gold (i.e. almost pure).
[4] Figure reported as refined metal.
[5] Refinery production for Japan was as follows: 1973—1,052,775 ounces; 1974—1,123,474 ounces; 1975—1,043,775 ounces.
[6] Bougainville Copper Ltd. produced the following amounts: 1973—634,558 ounces; 1974—683,974 ounces; 1975—584,178 ounces. In addition, New Guinea produced the following amounts: 1973—[e] 8,000 ounces; 1974—8,662 ounces; 1975—[e] 8,000.

Graphite

By W. Timothy Adams [1]

Crystalline natural graphite was more available in 1975 as consumption decreased. However, the price of flake increased an average of 43% for all types and grades. Supplies of Mexican amorphous graphite were sufficient.

Imports of natural crystalline graphite from the Malagasy Republic increased slightly, and amorphous graphite imports decreased 36%. Exports of natural graphite decreased 13% to 10,586 tons.

Production of manufactured graphite decreased 22%. Expansion of facilities previously announced by several producers has been slowed because of decreased demand.

Table 1.—Salient natural graphite statistics

	1971	1972	1973	1974	1975
United States:					
Consumption [e] [1] short tons	60,000	70,000	79,000	94,867	70,000
Exports do	5,733	7,289	7,953	12,189	10,586
Value thousands	$680	$888	$992	$1,693	$1,890
Imports for consumption [2] short tons	57,756	64,135	77,431	82,636	65,663
Value thousands	$2,727	$3,847	[r] $4,494	$5,677	$5,698
World: Production short tons	433,925	[r] 397,894	[r] 435,150	[r] 541,085	484,942

[e] Estimate. [r] Revised.

[1] Estimated demand has been substituted for the consumption survey results previously published, since the latter are incomplete. A figure comparable to the previous series appears as the total of table 4.

[2] Includes some manufactured graphite.

Legislation and Government Programs.—As part of an effort to reduce strategic stockpile inventories, more than 50% of the natural graphite in the stockpile was declared excess by the General Services Administration (GSA). For strategic stockpile materials, congressional authorization is required before disposal. Of the three types of stockpiled graphite, about 50% of the Malagasy crystalline flake and Sri Lanka lump and chip and all of the crystalline flake other than Malagasy flake were placed on the excess list. Congressional authorization for this disposal was not obtained and no sales were made. However, all stockpiled graphite that had previously been authorized for disposal was sold and shipped. Removal of the import duty on crystalline flake graphite for a trial period of 3 years was requested.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 2.—Government yearend stocks of natural graphite
(Short tons)

Type of graphite	National stockpile
Malagasy crystalline flake:	
Objective	4,900
Uncommitted excess	5,900
Total	10,800
Malagasy crystalline fines:	
Objective	3,300
Uncommitted excess	[1] 3,839
Total	[1] 7,139
Sri Lanka amorphous lump:	
Objective	3,100
Uncommitted excess	[2] 2,399
Total	[2] 5,499
Other than Malagasy and Sri Lanka, crystalline: Uncommited excess	[3] 2,802

[1] Includes 1 short ton nonstockpile-grade material.
[2] Includes 56 short tons nonstockpile-grade material.
[3] Includes 867 short tons nonstockpile-grade material.

Source: General Services Administration. Stockpile Report to the Congress, July-December 1975.

DOMESTIC PRODUCTION

In 1975, natural graphite production in the United States was again from a single location, the Southwestern Graphite Co. near Burnet, Tex. Shipments from the mine were approximately the same as in 1974, and continued to account for only a small portion of the domestic supply. Other graphite deposits in Alabama, New York, Texas, and the Province of Saskatchewan, Canada, continued to arouse the interest of investigators contemplating the development or redevelopment of additional mines. However, no mine openings had occurred by yearend.

Reported production of manufactured graphite products decreased in 1975. Output of 250,443 tons was down 22% from the 322,513 tons reported in 1974. Total value of production increased 10% to $307.6 million from $280.1 million in 1974. The production of powder and scrap is estimated to have decreased to 27,589 tons valued at $1.8 million in 1975.

Manufactured graphite was produced at 25 plants in 1975, and some additional production for inhouse use was likely. The following is a list of principal producers in 1975:

Company	Plant Location
Airco, Inc., Speer Div	Niagara Falls, N.Y.
Do	Punxsutawney, Pa.
Do	St. Marys, Pa.
Avco Corp., Avco Systems Div	Lowell, Mass.
The Carborundum Co., Graphite Products Div	Hickman, Ky.
Do	Sanborn, N.Y.
Celanese Corp., Celanese Research Lab	Summit, N.J.
Fiber Materials, Inc	Graniteville, Mass.
Great Lakes Carbon Corp	Rosamond, Calif.
Do	Niagara Falls, N.Y.
Do	Morganton, N.C.
Hercules, Inc	Bacchus, Utah.
HITCO	Gardena, Calif.
Morganite Modmor, Inc	Costa Mesa, Calif.
Ohio Carbon Co	Cleveland, Ohio.
Pfizer, Inc., Minerals Pigments & Metals Div	Easton, Pa.
Poco Graphite, Inc	Decatur, Tex.
Polycarbon, Inc	North Hollywood, Calif.
Stackpole Carbon Co	Lowell, Mass.
Do	St. Marys, Pa.
Super Temp Co	Santa Fe Springs, Calif.
Union Carbide Corp	Niagara Falls, N.Y.
Do	Yabucoa, P.R.
Do	Columbia, Tenn.
Wickes Engineered Materials	Saginaw, Mich.

Expansion of manufactured graphite facilities listed in the 1974 Minerals Yearbook chapter was delayed by the decreased economic activity in 1975.

Table 3.—Production of manufactured graphite in the United States in 1975, by use

Use	Quantity (short tons)	Value (thousands)
Synthetic graphite products:		
Electrodes	177,048	$217,745
Crucibles and vessels	4,061	8,430
Motor brushes and machine shapes	618	2,403
Unmachined shapes	17,835	W
Cloth and fibers	168	W
Other [1]	50,713	52,345
Total	250,443	307,609
Synthetic graphic powder and scrap	27,589	1,758
Grand total	278,032	309,367

W Withheld to avoid disclosing individual company confidential data; included with "Total."
[1] Quantity includes anodes, refractories, high-modulus fibers, and other. Value includes anodes, unmachined shapes, cloth, fiber, high-modulus fibers, and other.

CONSUMPTION AND USES

Reported consumption for natural graphite declined 17% in 1975. Consumption in most categories declined in reflection of the general economic climate. Exports decreased to 10,600 tons. The Bureau of Mines canvass does not completely cover total consumption of natural graphite, which is estimated at approximately 70,000 tons of all types.

Economic conditions in 1975 made end use applications of reported manufactured graphite production difficult to estimate. Metallurgical use continued to be the principal consumer. It appears that electrodes and crucibles and vessels are the major end uses with unmachined shapes assuming greater importance. Graphite-fiber and carbon-fiber composites continued to gain consumer acceptance in the leisure product industries. Production costs of fiber decreased in 1975. The development of hybrid composites provided a combination of properties that extended the area of potential application. With the graphite fiber and hybrid composite fiber material available in broad woven form and with better fabrication techniques, assemblies became less labor intensive. Design and engineering began to emphasize cost as well as structural efficiency as the shift from development to production continued.

Table 4.—Consumption [1] of natural graphite in the United States in 1975, by use
(Short tons)

Use	Crystalline		Amorphous [2]		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Batteries	304	$465,091	387	$387,546	691	$852,637
Brake linings	654	414,796	899	443,015	1,553	857,811
Carbon products [3]	415	W	574	W	989	856,158
Crucibles, retorts, stoppers, sleeves, nozzles	2,914	1,120,026	1,301	596,313	4,215	1,716,339
Foundries	1,991	W	7,718	W	9,709	2,174,233
Lubricants [4]	1,062	595,237	2,076	664,955	3,138	1,260,192
Pencils	720	435,046	158	40,514	878	475,560
Powdered metals	101	W	92	W	193	189,453
Refractories	554	84,101	8,484	1,068,639	9,038	1,152,740
Rubber	97	50,077	131	40,230	228	90,307
Steelmaking	399	80,823	17,572	3,906,314	17,971	3,987,137
Other [5]	5,007	1,123,520	492	282,483	5,499	1,406,003
Total	14,218	5,499,996	39,884	9,518,574	54,102	15,018,570

W Withheld to avoid disclosing individual company confidential data; included in "Total."
[1] Consumption data incomplete; excludes small consuming firms.
[2] Includes mixtures of natural and manufactured graphite.
[3] Includes bearings and carbon brushes; previously titled "Other mechanical products."
[4] Includes ammunition, packings, and seed coating.
[5] Includes paints and polishes, antiknock and other compounds, drilling mud, electrical and electronic products, insulation, magnetic tape, small packages, and miscellaneous and proprietary uses.

PRICES

Graphite prices increased again in 1975 as the demand for high-grade natural graphite continued strong. Domestic prices responded to the higher cost since most of the U.S. supply is imported. The price of Malagasy crystalline flake and fines increased an average of 42% in price during 1975. Sri Lanka amorphous lump and chip decreased 9%. Mexican graphite, the principal amorphous type imported, increased 25% in price.

Price quotations represent a range. Actual prices are often on a negotiated basis between the buyer and seller. One source of information for imported graphite is the average value per ton of the different classes of imports, which can be computed from table 6. However, it should be kept in mind that these represent mainly shipments of unprocessed graphite.

No published source of domestic price quotations has been found that reflects the increases that have taken place in the past several years. Price information can be obtained from the companies that produce and import natural graphite. The following tabulation shows representative prices of several types of imported graphite as of December 1975 published in the Engineering and Mining Journal. All prices are f.o.b. the foreign port or border station and have been converted from metric tons.

	Per short ton	
	1974	1975
Flake and crystalline graphite, bags:		
Germany, West	$234–$1,495	$250–$1,000
Malagasy Republic	188– 558	220– 750
Norway	150– 247	160– 260
Sri Lanka	248– 446	248– 446
Amorphous, nonflake cryptocrystalline graphite (80% to 85% carbon):		
Korea, Republic of (bags)	30	40
Mexico (bulk)	28.50	36

FOREIGN TRADE

Exports of natural graphite decreased 13% in 1975. The principal buyer was Canada, which took 2,707 tons. Other countries purchasing several hundred tons each were Australia, Brazil, France, West Germany, Japan, Mexico, the Netherlands, Philippines, Spain, the United Kingdom, and Venezuela. Graphite was also exported to 20 additional countries.

Imports of natural graphite of all types decreased 21%. Imports of amorphous graphite from Mexico decreased 21% from 1974. Imports of crystalline flake from the Malagasy Republic increased 320 tons to 3,698 tons in 1975. The demand for refractory- and crucible-grade crystalline flake was active, but appears to have decreased somewhat.

Table 5.—U.S. exports of natural graphite,[1] by country

Destination	1974		1975	
	Quantity (short tons)	Value	Quantity (short tons)	Value
Angola	3	$650	51	$16,000
Argentina	286	39,130	116	24,545
Australia	934	103,046	362	45,736
Austria	98	7,688	--	--
Belgium-Luxembourg	109	11,335	35	3,534
Bolivia	82	11,552	--	--
Brazil	609	127,608	235	32,337
Canada	4,277	663,725	2,707	596,820
Chile	32	6,340	--	--
Colombia	55	9,498	50	18,093
Denmark	34	3,025	104	29,304
Finland	16	1,493	50	4,906
France	128	22,101	231	35,183
Germany, West	319	37,544	1,638	216,373
India	81	7,307	99	11,276
Indonesia	106	7,585	6	1,148
Iran	7	4,275	70	19,126
Israel	--	--	137	16,274
Italy	642	53,506	164	18,247
Japan	774	116,205	700	124,185
Korea, Republic of	77	15,845	--	--
Malaysia	53	6,873	--	--
Mexico	738	100,471	298	73,522
Netherlands	231	23,250	1,350	276,568
New Zealand	19	1,802	84	8,923
Norway	98	8,525	--	--
Panama	--	--	37	3,862
Paraguay	--	--	54	6,650
Peru	145	21,853	34	10,373
Philippines	245	26,386	249	31,755
Singapore	231	24,627	1	526
South Africa, Republic of	108	12,693	96	11,270
Spain	20	2,608	348	33,715
Sweden	144	16,751	61	8,453
Switzerland	51	3,915	33	3,370
Taiwan	35	4,513	34	3,659
United Kingdom	882	91,962	804	92,775
Venezuela	424	84,001	280	94,467
Other	96	13,086	68	16,743
Total	12,189	1,692,774	10,586	1,889,718

[1] Amorphous, crystalline flake, lump or chip, and natural, not elsewhere classified.

Table 6.—U.S. imports for consumption of natural and artificial graphite, by country

Year and country	Natural						Artificial [1]		Total	
	Crystalline flake		Crystalline lump, chip or dust		Other natural crude and refined					
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	3,768	$869	169	$49	73,112	$3,467	382	$109	77,431	$4,494
1974:										
Australia	--	--	--	--	11	2	--	--	11	2
Austria	--	--	--	--	20	4	--	--	20	4
Canada	--	--	46	2	21	1	1,281	118	1,348	121
China, People's Republic of	--	--	--	--	1,353	348	--	--	1,353	348
France	--	--	--	--	6	9	1	1	7	10
Germany, West	536	301	--	--	2,268	625	62	21	2,866	947
Hong Kong	--	--	--	--	139	30	--	--	139	30
Israel	--	--	--	--	(2)	(2)	--	--	(2)	(2)
Italy	--	--	--	--	9	14	--	--	9	14
Japan	--	--	--	--	1	3	18	49	19	52
Korea, Republic of	--	--	--	--	273	31	--	--	273	31
Malagasy Republic	3,378	583	--	--	425	68	--	--	3,803	651
Malaysia	187	23	--	--	--	--	--	--	187	23
Mexico	--	--	--	--	63,294	1,495	--	--	63,294	1,495
Netherlands	--	--	--	--	3	1	(2)	1	3	2
Norway	--	--	--	--	2,447	363	--	--	2,447	363
South Africa, Republic of	7	1	--	--	13	2	--	--	20	3
Sri Lanka	84	20	336	117	2,403	677	--	--	2,823	814
Switzerland	--	--	--	--	--	--	162	103	162	103
Taiwan	--	--	--	--	409	81	--	--	409	81
U.S.S.R	548	75	--	--	2,842	498	--	--	3,390	573
United Kingdom	--	--	--	--	11	2	42	8	53	10
Total	4,740	1,003	382	119	75,948	4,254	1,566	301	82,636	5,677
1975:										
Belgium-Luxembourg	(2)	(2)	--	--	--	--	--	--	(2)	(2)
Brazil	2	1	--	--	--	--	--	--	2	1
Canada	247	75	32	19	51	13	1,241	144	1,571	251
China, People's Republic of	--	--	--	--	2,500	792	--	--	2,500	792
France	--	--	--	--	6	9	--	--	6	9
Germany, West	139	89	--	--	899	345	13	26	1,051	460
Hong Kong	--	--	--	--	20	7	--	--	20	7
Indonesia	183	44	--	--	67	12	--	--	250	56
Italy	--	--	--	--	(2)	2	--	--	(2)	2
Japan	--	--	--	--	11	2	39	107	50	109
Malagasy Republic	3,698	908	--	--	271	66	--	--	3,969	974
Mexico	--	--	--	--	50,283	1,488	--	--	50,283	1,488
Netherlands	--	--	--	--	3	1	--	--	3	1
Norway	--	--	--	--	1,321	326	--	--	1,321	326
Sri Lanka	1	1	218	69	2,017	590	--	--	2,236	660
Switzerland	--	--	--	--	--	--	80	63	80	63
Taiwan	--	--	--	--	(2)	(2)	--	--	(2)	(2)
U.S.S.R	--	--	--	--	2,280	475	--	--	2,280	475
United Kingdom	--	--	(2)	3	41	21	(2)	(2)	41	24
Total	4,270	1,118	250	91	59,770	4,149	1,373	340	65,663	5,698

[1] Includes only that received in raw material form; excludes products made of graphite.
[2] Less than ½ unit.

WORLD REVIEW

World production of natural graphite decreased 10%. Production of amorphous graphite in Mexico and the Republic of Korea continued to be adequate. The shortage of Malagasy crystalline flake appears to have eased somewhat. Industry continued to look for sources of crystalline flake other than the Malagasy Republic.

Table 7.—Graphite: World production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
Argentina	104	42	[e] 45
Austria	18,972	32,573	33,715
Brazil (marketable)	[2] 3,133	[e] 3,000	[e] 3,000
Burma	202	[3] 336	96
China, People's Republic of [e]	33,000	44,000	55,000
Germany, West	[4] 14,909	[4] 18,172	[e] 18,000
India	[e] 22,000	25,420	20,824
Italy	4,587	2,789	[e] 1,900
Korea, North [e]	85,000	85,000	85,000
Korea, Republic of	48,065	115,589	52,064
Malagasy Republic	15,392	19,049	19,592
Mexico	72,082	[r] [e] 66,900	67,036
Norway	7,359	10,488	[e] 11,000
Romania [e]	6,600	6,600	6,600
Sri Lanka	8,611	[5] 10,414	11,493
South Africa, Republic of	1,134	1,713	577
U.S.S.R.[e]	[r] 94,000	[r] 99,000	99,000
United States	W	W	W
Total	[r] 435,150	541,085	484,942

[e] Estimate. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] In addition to the countries listed, Czechoslovakia, Japan, Southern Rhodesia, and the Territory of South-West Africa are believed to produce graphite, but available information is inadequate for formulation of reliable estimates of output levels.
[2] Beneficiated product.
[3] Data for year Apr. 1, 1974, through Mar. 31, 1975.
[4] Represents marketable production, including some imported graphite.
[5] Exports.

TECHNOLOGY

A small, integrated plate or hot strip mill now appears economically feasible because it bypasses much of the equipment and processes used in conventional steelmaking. The key elements of these miniworks are direct reduction of iron ore to provide the major portion of iron for melting; electric arc furnaces to convert the cold iron into liquid steel, and controlled pressure pouring (CPP) to convert the molten steel into slabs for rolling. An essential part of the process is the use of large machined graphite blocks as slab molds. Metal cast into the coated graphite mold gives a slab with excellent surface qualities.[2]

Use of graphite-alumina refractories developed by Vesuvius Crucible Co., Pittsburgh, Pa., for continuous casting of alloy steel maintains the quality of the as-cast metal. The refractories have good mechanical strength and high thermal conductivity to resist thermal shock. The system maintains the quality of the alloy by protecting the molten metal from the atmosphere as the metal is passed from the ladle, to the tundish, to the headbox of the continuous casting machine.

Graphite and carbon fibers increased in importance as research and development continued and the shift to production items accelerated. A full-scale aircraft wing of advanced composites built to McDonnell-Douglas F-15 wing specifications was static tested. It was concluded that large composite wings can withstand mechanical loads identical to those experienced by metal wings. The composite wing was 10% lighter in weight, and indications are that it would cost less to fabricate.[3] An Air Force study known as the Advanced Design Composite Aircraft was announced. The goal of the study is to create the design of a new aircraft that would have up to 70% of its airframe made by graphite composites. The project is managed by the Flight Dynamics Laboratory at Wright-Patterson Air Force Base.[4]

An advanced low-thrust rocket motor developed by Jet Propulsion Laboratories has a graphite-epoxy combustion chamber. Overall dimensions of the motor case are 25.6 inches in diameter and 26 inches long. NASA/Lewis developed a hybrid composite material composed of graphite epoxy and boron aluminum interspersed

[2] Brown, Darwyn I. Mini and Medium Steel Plants of North America—A Round Up. Iron and Steel Eng., v. 52, No. 11, pp. MMM13–MMM19.
Jeffreys, L. W. The Integrated Mini-Mill for Hot Rolled Strip and Plate Is Now Economical. Iron and Steel Eng., v. 52, No. 8, pp. 65–66.
[3] Materials Engineering. V. 81, No. 6, June 1975, p. 56.
[4] Industrial Research. V. 17, No. 9, September 1975, pp. 19–20.

with titanium metal foil. The material showed improved strength and stiffness for multidirectional loading, improved resistance to cyclic loading, and improved impact and erosion resistance.[5]

An interesting review of fiber composites outlined the various types of composites presently used; including their advantages, disadvantages, and present and potential applications.[6]

A comparison of inorganic fibers was published. The basic properties and available forms of major inorganic manmade fibers are listed and compared. The confusion over carbon and graphite fibers is clarified.[7]

Thagard Technology Co. has developed an unusual high-temperature reactor. Heat is transferred via radiation instead of convection or conduction. Various gases serve as a blanketing fluid to protect the internal walls of the reaction tube from the reactants and their products. Heat shields, spiral heat exchangers, insulation, and reaction tubes are fabricated from various forms of carbon and graphite fibers. The temperature of the reactor is easily controlled, and the tube temperature responds quickly to any change in the thermal load of the entering reactants.[8]

A graphite resistance furnace with a very low thermal mass having accurate temperature control and capable of precision drawing silica-based fibers at temperatures up to 2,000° C was constructed. Working temperatures were reached in a very short time. Power consumption was low, and recovery from transient temperature disturbances was rapid. The entire furnace was constructed of various forms of graphite products including felt, string, cloth, paper, and machined graphite. The apparatus was strong and reliable in operation and was considered suitable for routine production operations.[9]

A composite paint extender of mica with 5% contained graphite was produced by Micalith Mining Co. of Phoenix, Ariz. The product is claimed to be suitable for use in anticorrosive systems for imparting strength and adhesion.[10]

A new self-lubricating, dry bearing material consists of high-purity powders alloyed into a strong graphite-impregnated bronze matrix. The material is said to be impervious to nearly all solvents and foreign matter. It can operate at sustained temperatures up to 1,000° F.[11]

The first International Titanium Casting Seminar was held in London. The "Mono-Graf" graphite shell casting system was described. Six U.S. companies produce titanium castings; three use the rammed graphite technique, and the others use the investment process.[12]

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[5] Work cited in footnote 3.
[6] Iron Age. Now Fiber Composites Also Reduce Costs. V. 215, No. 24, June 16, 1975, pp. 41–45.
[7] Miska, K. H. Primer on Inorganic Man-made Fibers. Materials Processing, v. 82, No. 2, August 1975, pp. 20–23.
[8] Chemical Engineering. Unique Reactor Thrives at High Temperatures. V. 82, No. 23, Oct. 27, 1975, pp. 64–68.
[9] Payne, D. N., and W. A. Gambling. A Resistance-Heated High Temperature Furnace for Drawing Silica-Based Fibers for Optical Communications. Am. Ceram. Soc. Bull., v. 55, No. 2, February 1976, pp. 195–197.
[10] Mayhew L. D. Inorganic Materials in Paint Manufacture. Industrial Minerals, No. 99, December 1975, p. 35.
[11] Metal Progress. New Products: Dry Bearing Material Counters Wear. V. 108, No. 6, November 1975, p. 15.
[12] Foundry Management and Technology. A First for Titanium Castings. V. 103, No. 7, July 1975, pp. 90–91.

Gypsum

By Avery H. Reed [1]

The gypsum industry continued to decline in 1975 owing to the continued depression in the building industries. Output of crude gypsum declined 19% to 9.8 million tons. Production of calcined gypsum declined 16% to 9.2 million tons. Sales of gypsum products declined 17% to 15.6 million tons. Imports of crude gypsum declined 27% to 5.4 million tons. Total value of gypsum products sold declined 18% to $514 million.

Domestic demand for gypsum is expected to increase 2% per year and reach 35 million tons by 2000.

Table 1.—Salient gypsum statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Active mines and plants [1]	107	108	112	116	110
Crude: [2]					
Mined	10,418	12,328	13,558	11,999	9,751
Value	$39,057	$48,504	$56,650	$52,894	$44,654
Imports for consumption	6,094	7,718	7,661	7,424	5,448
Calcined:					
Produced	9,526	12,005	12,592	10,993	9,181
Value	$151,991	$195,862	$205,326	$205,713	$186,478
Products sold (value)	$435,257	$560,569	$632,809	$623,102	$513,617
Exports (value)	$4,214	$5,276	$7,360	$10,844	$10,481
Imports for consumption (value)	$16,332	$22,042	$21,937	$21,889	$19,810
World: Production	58,421	64,470	r 67,829	r 64,622	60,305

r Revised.
[1] Each mine, calcining plant, or combination mine and plant is counted as one establishment.
[2] Excludes byproduct gypsum.

DOMESTIC PRODUCTION

Thirty-nine companies mined crude gypsum at 68 mines in 22 States. Output declined 19% and was 28% below the 1973 record. Leading producing States were California, Michigan, Iowa, Texas, and Oklahoma. These five States each produced more than 1 million tons and together accounted for 62% of total domestic production. Stocks of crude ore at mines at yearend were 1.0 million tons.

Leading companies were United States Gypsum Co. (14 mines), National Gypsum Co. (7 mines), Georgia-Pacific Corp. (6 mines), Celotex Corp. (4 mines), Flintkote Company (3 mines), and H. M. Holloway Inc. (1 mine). These 6 companies, operating 35 mines, produced 79% of the total crude gypsum.

Leading individual mines were United States Gypsum's Plaster City mine in Imperial County, Calif.; National Gypsum's Tawas mine in Iosco County, Mich.; H. M. Holloway's Lost Hills mine in Kern County, Calif.; United States Gypsum's Southard mine in Blaine County, Okla.; and United States Gypsum's Shoals mine in Martin County, Ind. These five mines accounted for 27% of the national total. Average output per mine for the 68 U.S. mines was 143,000 tons, compared with 160,000 tons per mine in 1974 and 196,000 tons in 1973.

[1] Supervisory physical scientist, Division of Nonmetallic Minerals.

Thirteen companies calcined gypsum at 74 plants in 29 States. Output declined 16% and was 27% below the 1973 record. Leading States were California, Iowa, Texas, New York, and Indiana. These 5 States, with 28 plants, accounted for 44% of the national total.

Leading companies were United States Gypsum Co. (23 plants), National Gypsum Co. (18 plants), Georgia Pacific Corp. (9 plants), Flintkote Company (6 plants), and Celotex Corp. (5 plants). These 5 companies, operating 61 plants, accounted for 87% of the national total.

Leading individual plants were United States Gypsum's Plaster City plant, Imperial County, Calif.; United States Gypsum's Shoals plant, Martin County, Ind.; United States Gypsum's Stony Point plant, Rockland County, N. Y.; United States Gypsum's Southard plant, Blaine County, Okla.; National Gypsum's Shoals plant, Martin County, Ind.; United States Gypsum's Ft. Dodge plant, Webster County, Iowa; and Weyerhauser's Briar plant, Howard County, Ark. These seven plants accounted for 21% of the national total. Average output per plant for the 74 U.S. plants was 124,000 tons, compared with 145,000 tons per plant in 1974 and 166,000 tons in 1973.

Occidental Petroleum Corp., Valley Nitrogen Producers Inc., Collier Carbon & Chemical Corp., and California Industrial Minerals Co., (all in California); and Universal Gypsum Co. of Indiana Inc., in Indiana, sold 369,000 tons of byproduct gypsum valued at $2.9 million for agricultural purposes.

The United States is the world's leading producer of gypsum, accounting for 16% of total world output.

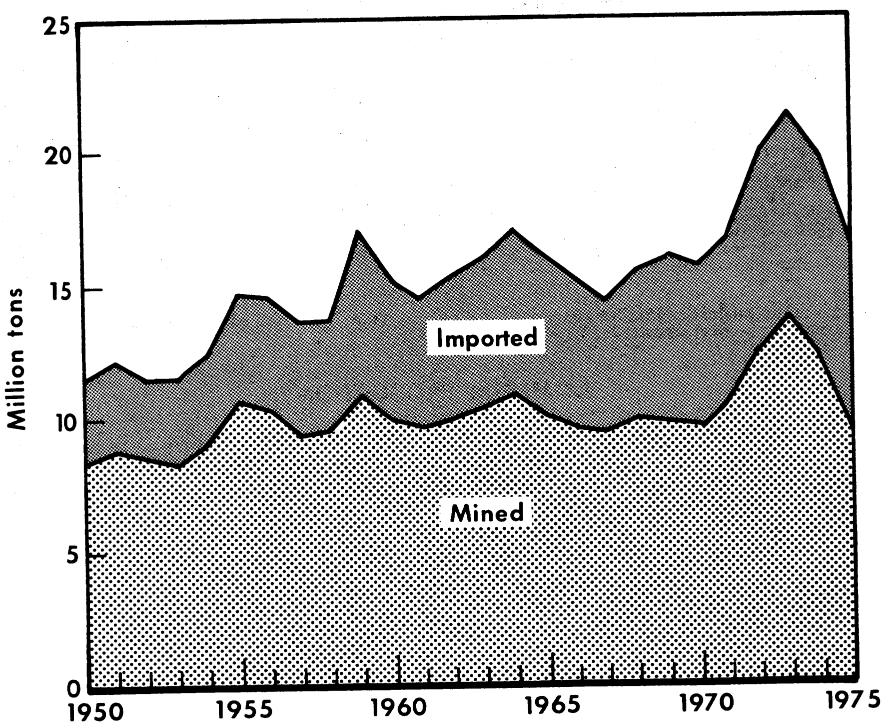

Figure 1.—Supply of crude gypsum in the United States.

Table 2.—Crude gypsum mined in the United States, by State
(Thousand short tons and thousand dollars)

State	1974 Active mines	1974 Quantity	1974 Value	1975 Active mines	1975 Quantity	1975 Value
Arizona	4	141	473	4	117	419
California	5	1,716	6,642	4	1,446	6,332
Colorado	5	191	800	4	185	782
Iowa	6	1,397	7,142	6	1,208	6,546
Michigan	5	1,482	7,258	5	1,224	5,936
Nevada	4	843	2,959	4	558	2,375
Oklahoma	7	1,225	5,622	7	1,028	4,835
South Dakota	2	32	135	1	23	60
Texas	8	1,365	5,276	7	1,094	4,277
Utah	5	248	1,076	5	247	1,457
Wyoming	3	315	960	3	271	902
Other States [1]	21	3,044	14,551	18	2,350	10,733
Total	75	11,999	52,894	68	9,751	44,654

[1] Includes Arkansas, Idaho, Indiana, Kansas, Louisiana, Montana, New Mexico, New York, Ohio, Virginia, and Washington.

Table 3.—Calcined gypsum produced in the United States, by State
(Thousand short tons and thousand dollars)

State	1974 Active plants	1974 Quantity	1974 Value	1975 Active plants	1975 Quantity	1975 Value
California	7	1,123	16,242	7	1,035	15,849
Florida	3	547	9,045	3	344	7,038
Georgia	3	644	13,161	3	512	11,225
Iowa	5	896	15,634	5	851	17,802
Michigan	4	443	8,629	4	385	9,689
Nevada	3	383	6,374	3	319	6,148
New Jersey	4	549	7,753	4	433	5,254
New York	7	954	18,042	6	716	13,494
Ohio	3	379	6,272	3	339	5,180
Texas	7	1,096	22,657	7	842	19,428
Other States [1]	30	3,979	81,904	29	3,405	75,371
Total	76	10,993	205,713	74	9,181	186,478

[1] Includes Arizona, Arkansas, Colorado, Delaware, Illinois, Indiana, Kansas, Louisiana, Maryland, Massachusetts, Montana, New Hampshire, New Mexico, Oklahoma, Pennsylvania, Utah, Virginia, Washington, and Wyoming.

CONSUMPTION AND USES

Apparent consumption of crude gypsum (production plus imports minus exports) declined 22% to 15.2 million tons. Imports provided 36% of consumption. Apparent consumption of calcined gypsum declined 16% to 9.1 million tons.

Stocks of crude gypsum at mines and calcining plants at yearend were 2.9 million tons. Of this, 1.7 million tons (59%) was at calcining plants in coastal States.

Of the total gypsum products sold or used, 4.9 million tons (31%) was uncalcined. Of the total uncalcined gypsum, 3.2 million tons (66%) was used for portland cement, and 1.5 million tons (30%) was used in agriculture. The leading sales regions for gypsum used in cement were the West South-Central, West North-Central, and Pacific; the three regions accounted for 44% of the total. For agricultural gypsum, the Pacific sales region accounted for 82% of the total.

Of the total calcined gypsum, 92% was used for prefabricated products and 8% for plasters. Of the prefabricated products, 76% was regular wallboard, 16% was fire-resistant Type X wallboard, and only 1% was lath. Of the regular wallboard, 82% was ½ inch and 10% was ⅜ inch. The leading sales regions for prefabricated products were the South Atlantic, East North-Central, and the Pacific; the three regions accounted for 48% of the total. For plaster, the East North-Central, Middle Atlantic, and South Atlantic regions accounted for 60% of the total.

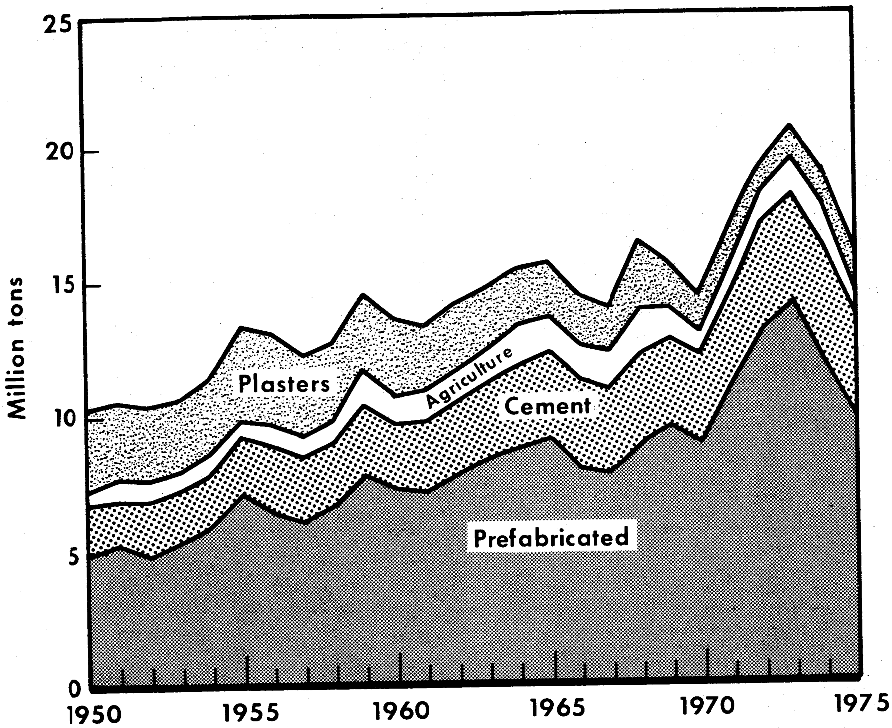

Figure 2.—Sales of gypsum products by use.

Table 4.—Gypsum products (made from domestic, imported, and byproduct gypsum) sold or used in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974		1975	
	Quantity	Value	Quantity	Value
Uncalcined:				
Portland cement	4,058	24,122	3,244	21,341
Agriculture	1,671	12,728	1,482	9,138
Other	123	1,897	178	2,588
Total	5,852	38,747	4,904	33,067
Calcined:				
Industrial plaster	326	14,626	294	14,847
Building plaster:				
Regular base coat	215	6,467	176	6,120
Mill-mixed base coat	142	5,412	125	5,356
Veneer plaster	81	5,174	73	4,907
Other [1]	191	6,610	162	6,232
Total [2]	629	23,664	535	22,615
Prefabricated products [3]	11,886	546,065	9,855	443,089
Total calcined [2]	12,841	584,355	10,684	480,550
Grand total	18,693	623,102	15,588	513,617

[1] Includes gaging, molding, and Keene's cement, roof deck concrete, and other uses.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes weight of paper, metal, or other materials.

Table 5.—Prefabricated products sold or used in the United States, by product

Product	1974 Thousand square feet	1974 Thousand short tons [1]	1974 Value (thousands)	1975 Thousand square feet	1975 Thousand short tons [1]	1975 Value (thousands)
Lath:						
3/8-inch	247,053	194	$9,448	171,922	135	$7,144
1/2-inch	11,503	11	457	9,142	8	397
Total	258,556	205	9,905	181,064	143	7,541
Veneer base	344,048	316	14,818	292,188	278	12,975
Sheathing	250,737	240	11,056	199,340	189	9,098
Regular gypsumboard:						
3/8-inch	972,624	769	36,435	926,841	736	24,027
1/2-inch	8,049,276	7,204	310,074	6,952,283	6,171	267,140
5/8-inch	268,139	265	10,914	490,594	465	24,919
1 inch	24,845	45	2,509	15,978	31	1,935
Other [2]	124,675	110	5,492	129,774	103	5,177
Total [3]	9,439,559	8,393	365,425	8,515,470	7,507	323,197
Type X gypsumboard	2,446,306	2,570	122,563	1,408,512	1,600	70,655
Predecorated wallboard	164,642	156	20,046	135,462	130	17,749
Other	6,502	6	2,252	9,972	8	1,873
Grand total [3]	12,910,350	11,886	546,065	10,742,008	9,855	443,089

[1] Includes weight of paper, metal, or other material.
[2] Includes 1/4-inch, 5/16-inch, 5/8-inch, and 3/4-inch gypsumboard.
[3] Data may not add to totals shown because of independent rounding.

PRICES

The value of crude gypsum increased from $4.41 per ton in 1974 to $4.58 in 1975. The value of calcined gypsum increased from $18.71 in 1974 to $20.31 in 1975. The average value of byproduct gypsum sold decreased from $9.29 to $7.96 per ton in 1975.

The average value of gypsum products sold or used decreased from $33.33 to $32.95 per ton in 1975. Prefabricated products were valued at $44.96, industrial plasters at $50.50, building plaster at $42.27, and uncalcined products at $6.74 per ton.

Quoted prices for gypsum are published monthly in Engineering News-Record. Prices at yearend showed a wide range, based on delivered prices. Regular 1/2-inch wallboard prices ranged from $44 per thousand square feet at Dallas to $90 at Chicago. Prices for building plaster ranged from $68 per ton at Philadelphia to $94 at Denver.

FOREIGN TRADE

The gypsum industry depended on imports in 1975 for 36% of the crude gypsum supply. Imports were from Canada (74%), Mexico (19%), Jamaica (5%), and the Dominican Republic, the United Kingdom, and Italy (2%). Imports decreased 27% to 5.4 million tons. Most of the imported crude gypsum was mined by U.S. companies.

Table 6.—U.S. exports of gypsum and gypsum products
(Thousand short tons and thousand dollars)

Year	Crude, crushed, or calcined: Quantity	Crude, crushed, or calcined: Value	Other manufactures n.e.c. (value)	Total value
1973	63	3,135	4,225	7,360
1974	132	3,910	6,934	10,844
1975	75	4,505	5,976	10,481

Table 7.—U.S. imports for consumption of gypsum and gypsum products
(Thousand short tons and thousand dollars)

Year	Crude		Ground or calcined		Alabaster manufactures[1]	Other manufactures n.e.c.	Total value
	Quantity	Value	Quantity	Value	Value	Value	
1973	7,661	17,572	2	123	1,914	2,328	21,937
1974	7,424	17,602	2	107	1,976	2,204	21,889
1975	5,448	16,021	2	172	1,365	2,252	19,810

[1] Includes imports of jet manufactures, which are believed to be negligible.

Table 8.—U.S. imports for consumption of crude gypsum, by country
(Thousand short tons and thousand dollars)

Country	1974		1975	
	Quantity	Value	Quantity	Value
Canada	5,727	14,026	4,022	11,344
Dominican Republic	230	924	123	2,438
Italy	(1)	12	(1)	9
Jamaica	238	546	274	659
Mexico	1,185	1,766	1,027	1,567
Morocco	23	83	--	--
United Kingdom	18	44	2	4
Venezuela	3	201	--	--
Total	7,424	17,602	5,448	16,021

[1] Less than ½ unit.

WORLD REVIEW

Domestic and foreign resources of gypsum are adequate for any foreseeable time. World reserves are conservatively estimated at 2 billion tons.

Canada.—Canada was the third leading producer of crude gypsum, accounting for 10% of the world total. Most of the gypsum was mined by U.S. companies and exported to the United States.

France.—France was the second leading gypsum producing country, with 11% of the world total.

South Africa.—Gypsum reserves in Cape Province were reported to be "too extensive to justify the time required to arrive at a total tonnage." Gypsum beds range from 3 to 7 feet thick and average 70% gypsum. The gypsite is upgraded to 90% gypsum by washing out the clay. Production is used locally.

Spain.—Spain ranked fifth in world gypsum production with 8% of the total.

U.S.S.R.—The U.S.S.R. produced 9% of the world's gypsum and ranked fourth.

Yugoslavia.—Construction started on a $1.4 million gypsum plant at Donji Vakuf, Bosnia.

Table 9.—Gypsum: World production, by country
(Thousand short tons)

Country[1]	1973	1974	1975 p
North America:			
Canada (shipments)[2]	8,389	7,964	6,255
Dominican Republic	253	r e 220	[3]162
Ecuador	(4)	(4)	(4)
El Salvador e	7	7	7
Guatemala	9	e 14	14
Honduras	15	9	1
Jamaica	393	296	264
Mexico	1,669	1,529	1,384
Nicaragua e	39	39	39
United States	13,558	11,999	9,751

See footnotes at end of table.

Table 9.—Gypsum: World production, by country—Continued

(Thousand short tons)

Country [1]	1973	1974	1975 p
South America:			
Argentina	501	366	e 366
Bolivia [5]	1	4	1
Brazil	388	436	e 480
Chile	98	149	199
Colombia	248	345	410
Paraguay	12	16	17
Peru	27	e 27	e 27
Venezuela	187	181	233
Europe:			
Austria [2]	960	886	788
Belgium [2]	126	113	244
Bulgaria	182	198	209
Czechoslovakia	637	693	702
France [2]	r 6,790	6,906	6,408
Germany, East e	375	375	375
Germany, West (marketable)	3,250	2,168	e 2,200
Greece	463	463	485
Ireland	481	423	365
Italy e	3,858	3,858	3,856
Luxembourg	6	4	5
Poland e	937	937	937
Portugal	e 149	158	e 160
Spain	4,928	r e 4,600	4,600
Switzerland e	110	110	110
U.S.S.R. e	r 5,200	r 5,200	5,500
United Kingdom	4,243	3,932	e 4,000
Yugoslavia	283	312	[2] e 413
Africa:			
Algeria e	193	193	193
Angola	51	44	44
Egypt	577	616	606
Ethiopia	--	2	--
Kenya [2] e	100	110	110
Libya	e 4	4	e 4
Mauritania	2	9	14
Niger	e 2	2	1
South Africa, Republic of	533	621	594
Sudan [2]	33	33	1
Tanzania	14	23	26
Zambia	1	4	8
Asia:			
Burma	17	e 30	43
China, People's Republic of e	r 700	r 770	880
Cyprus	55	28	e 28
India	r 977	1,183	893
Indonesia e	9	9	9
Iran e	2,646	2,646	2,646
Israel	165	220	220
Japan	r 406	368	217
Jordan	33	33	33
Korea, Republic of	e 165	353	350
Lebanon	11	14	e 14
Mongolia e	28	28	28
Pakistan	196	207	[6] 309
Philippines	r 119	139	130
Saudi Arabia e	50	50	50
Syrian Arab Republic e	17	17	17
Taiwan	6	4	3
Thailand	260	344	281
Turkey	395	394	478
Vietnam, South e	8	8	8
Oceania: Australia	r 1,284	1,179	e 1,100
Total	r 67,829	64,622	60,305

e Estimate. p Preliminary. r Revised.
[1] Gypsum is also produced in Cuba and Romania, but production data are not available.
[2] Includes anhydrite.
[3] Shipments.
[4] Less than ½ unit.
[5] Net exports.
[6] Twelve months November 1974 through October 1975.

Helium

By Thomas G. Clarke [1]

In 1975, total domestic sales of high purity helium (minimum 99.995% purity) increased 5% to 601 million cubic feet, compared with 570 million cubic feet in 1974.[2] The Bureau of Mines plants sold 31% of the 1975 total, and private industry accounted for the remainder. Exports of high purity helium in 1975, all by industry, were 144 million cubic feet, 12% higher than in 1974. The Bureau of Mines plant price remained at $35 per thousand cubic feet in 1975, but private industry prices rose slightly to $24 per thousand cubic feet.

An earlier ruling by a trial judge of the Court of Claims that Northern Helex Co. was entitled to $78 million in damages because the Government had breached its helium purchase contract with the company was reversed by the full U.S. Court of Claims in October 1975. The full court reduced the award to $35 million and remanded the case to the trial judge for consideration of possible further reductions.

At yearend 1975, litigation was still pending with respect to claims arising from the termination of helium purchase contracts with the National Helium Corp. and Cities Service Helex, Inc.

DOMESTIC PRODUCTION

A total of 12 domestic plants had the capacity to extract helium from natural gas during 1975. Ten of the plants were owned by private industry, and the other two are owned by the U.S. Government and operated by the Bureau of Mines. A new plant constructed by Western Helium Co. near Redrock, N. Mex., began helium extraction from natural gas in 1975.

Total domestic extraction of helium from natural gas during the year was 1.1 billion cubic feet, an increase of 22% compared with that in 1974. High purity helium extraction, however, increased only 7%, while that of crude helium was more than 81% higher than in 1974. Crude helium accounted for 31% of total helium extracted; about 69% was high purity helium for sale. The Bureau of Mines provided 55% of the crude helium and 25% of the high purity helium extracted. The remaining crude and high purity helium was extracted by private industry.

The construction phase of a new ionization chromograph was completed in June at the Bureau of Mines helium plant at Keyes, Okla. The new chromograph was designed for product quality analysis and has a minimum detectable limit for hydrogen in helium of less than 0.05 part per million and 0.5 part per million for other components. This new instrumentation will permit a high degree of sensitivity for quality control analysis of helium production.

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[1] Mineral specialist (petroleum), Division of Petroleum and Natural Gas.

[2] All helium statistics in this chapter are in terms of contained helium measured at 14.7 per square inch absolute and 70° F.

Table 1.—Helium extracted from natural gas in the United States
(Thousand cubic feet)

	1971	1972	1973	1974	1975 p
Crude helium: [1]					
Extracted at Bureau of Mines plants	r 504,506	262,197	175,976	169,414	183,725
Extracted at private industry plants	3,479,226	3,204,806	2,381,971	15,073	149,794
Total	3,983,632	3,467,003	2,557,947	184,487	333,519
High purity helium: [2]					
Extracted at Bureau of Mines plants	173,626	173,526	180,114	168,662	184,524
Extracted at private industry plants	403,152	453,675	467,102	[3] 530,312	[3] 560,899
Total	576,778	627,201	647,216	698,974	745,423
Grand total	4,560,410	4,094,204	r 3,205,163	883,461	1,078,942

p Preliminary. r Revised.
[1] Excludes crude helium purified after interplant transfer.
[2] Includes only those quantities produced for sale; quantities entering conservation storage system after purification are included under crude helium.
[3] Includes 28,657,000 cubic feet purified at the Bureau of Mines Keyes plant for private producers in 1974 and 39,396,000 cubic feet in 1975.

Table 2.—Ownership and location of helium extraction plants in the United States, 1975

Category and owner or operator	Location	Product purity
Government owned:		
Bureau of Mines	Exell, Tex	Crude helium.
Do	Keyes, Okla	Crude and high purity helium.
Private industry:		
Alamo Chemical-Gardner Cryogenics	Elkhart, Kans	High purity helium.
Cities Service Cryogenics, Inc	Scott City, Kans	Crude helium.[1]
Cities Service Helex, Inc	Ulysses, Kans	Crude and high purity helium.
Kansas Refined Helium Company	Otis, Kans	High purity helium.
Kerr-McGee Corp	Navajo, Ariz	Do.
National Helium Corp	Liberal, Kans	Crude helium.
Northern Helex Co	Buston, Kans	Crude helium.[2]
Phillips Petroleum Co	Dumas, Tex	Crude helium.
Do	Hansford County, Tex	Do.
Western Helium Co	Redrock, N. Mex	High purity helium.

[1] Output is piped to Cities Service Helex, Inc., plant at Ulysses, Kans., for purification.
[2] Output is being stored in the Bureau's Conservation System.

Table 3.—Summary of Bureau of Mines helium plant and Amarillo shipping terminal operations
(Thousand cubic feet)

	1973	1974	1975
Supply:			
Inventory at beginning of period[1]	16,142	8,632	9,291
Helium extracted:[2]			
Exell plant:			
Crude	60,525	35,036	36,111
High purity	--	--	--
Total Exell plant	60,525	35,036	36,111
Keyes plant:			
Crude	115,451	134,378	147,614
High purity	181,334	[3]170,194	[3]186,399
Total Keyes plant	296,785	304,572	334,013
Total extracted	357,310	339,608	370,124
Helium returned in containers (net)	3,539	2,935	1,349
Total supply	376,991	351,175	380,764
Disposal:			
Sales of high purity helium	180,114	168,662	184,524
Net deliveries to helium conservation system[4]	188,245	173,222	186,435
Inventory at end of period[1]	8,632	9,291	9,805
Total disposal	376,991	351,175	380,764

[1] At Exell and Keyes plants and at Amarillo shipping terminal.
[2] Excludes conservation helium produced from native gas withdrawal wells at Cliffside field that have been invaded by stored helium.
[3] Excludes 28,657,000 cubic feet purified for others in 1974 and 39,396,000 feet in 1975.
[4] Excludes return of conservation helium produced as indicated in footnote 2 to conservation storage system.

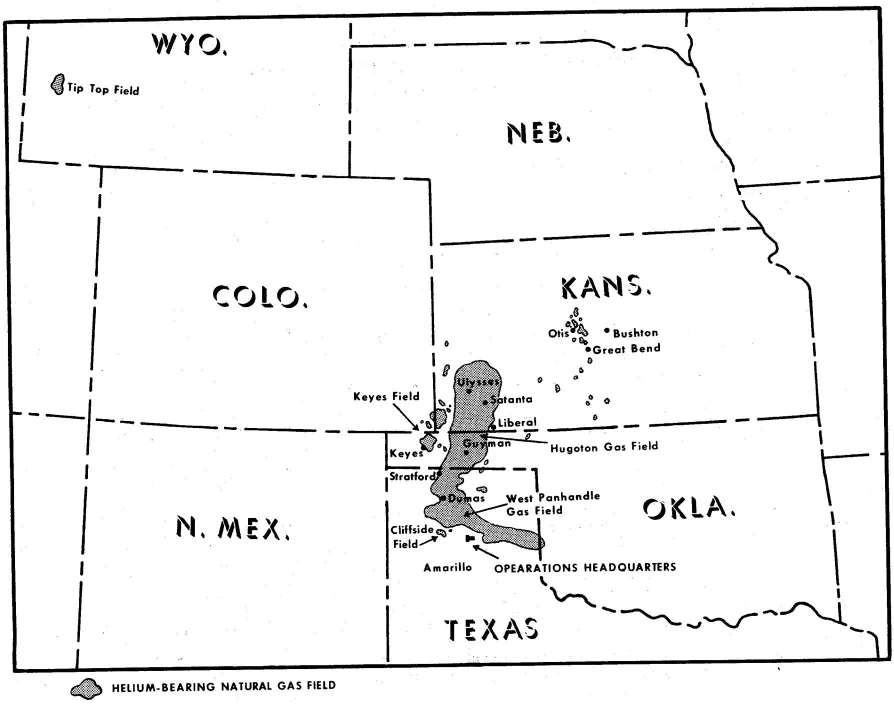

Figure 1.—Major U.S. helium-producing gasfields.

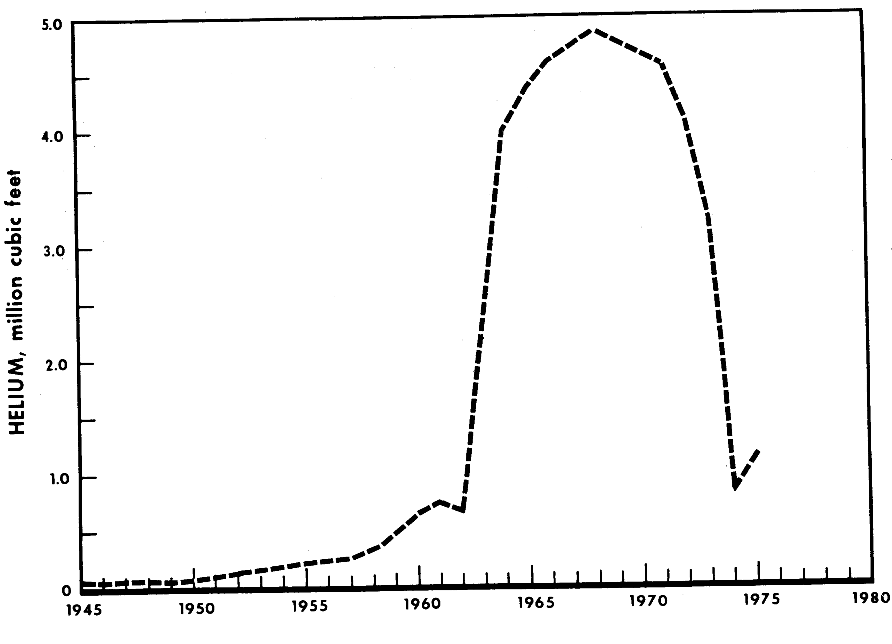

Figure 2.—Helium production in the United States, 1945–75.

CONSUMPTION AND USES

Domestic consumption of helium during 1975 was primarily for welding, research, purging and pressurizing rockets and spacecraft, maintenance of controlled atmospheres, leak detection, and cryogenics. Demand occurred principally in the Pacific and Gulf Coast States.

Sales of high purity helium in the United States increased about 5% during 1975. Bureau of Mines helium sales, which accounted for 31% of domestic sales, increased approximately 9% during the year.

Approximately 57% of the Bureau of Mines sales in 1975 were made directly to Federal agencies, which are required by law to purchase all of their major helium requirements[3] from the U.S. Department of the Interior. The Bureau of Mines f.o.b. plant price, which is set at $35 per thousand cubic feet for the purpose of financing the long-range helium conservation program, was not generally competitive with the 1975 average private f.o.b. plant price of $24 per thousand cubic feet.

Almost all of the remaining Bureau sales in 1975 were the result of purchases by Federal agencies from private distributors under General Services Administration contracts, which required the distributors to purchase equivalent quantities from the Bureau of Mines. These contracts made relatively small quantities of helium readily available to Federal installations with reduced freight charges for small purchases.

All high purity helium sold by the Bureau of Mines was shipped in gaseous form in cylinders, railroad tank cars, highway tanker trailers, and in liquid form in containerized dewars. Private industry distributors shipped helium in both gaseous and liquid forms. Much of the helium transported in liquid form was delivered by semitrailers and containerized dewars to distribution centers and regasified and compressed into small cylinders and trailers for delivery to consumers.

[3] In excess of 5,000 cubic feet per month.

Table 4.—Total sales of high purity helium in the United States
(Million cubic feet)

Year	Quantity
1971	r e 470
1972	r e 515
1973	r e 530
1974	r e 570
1975	p 601

e Estimate. p Preliminary. r Revised.

Table 5.—Bureau of Mines sales of high purity helium, by recipient
(Thousand cubic feet)

	1973	1974	1975 p
Federal agencies:			
Atomic Energy Commission [1]	17,627	21,169	17,184
Department of Defense	47,766	45,432	60,551
National Aeronautics and Space Administration	34,739	13,684	21,046
National Weather Service	2,767	2,957	1,746
Other [2]	3,581	4,298	4,968
Total Federal agencies	106,480	87,540	105,495
Private helium distributor sales [3]	73,634	81,222	77,049
Commercial sales			1,980
Grand total	180,114	168,662	184,524

p Preliminary.
[1] Became part of Energy Research and Development Administration on Jan. 19, 1975.
[2] Includes quantities used by Bureau of Mines.
[3] Most of this was purchased by commercial firms which sold equivalent quantities to Federal installations under contract agreements with the General Services Administration.

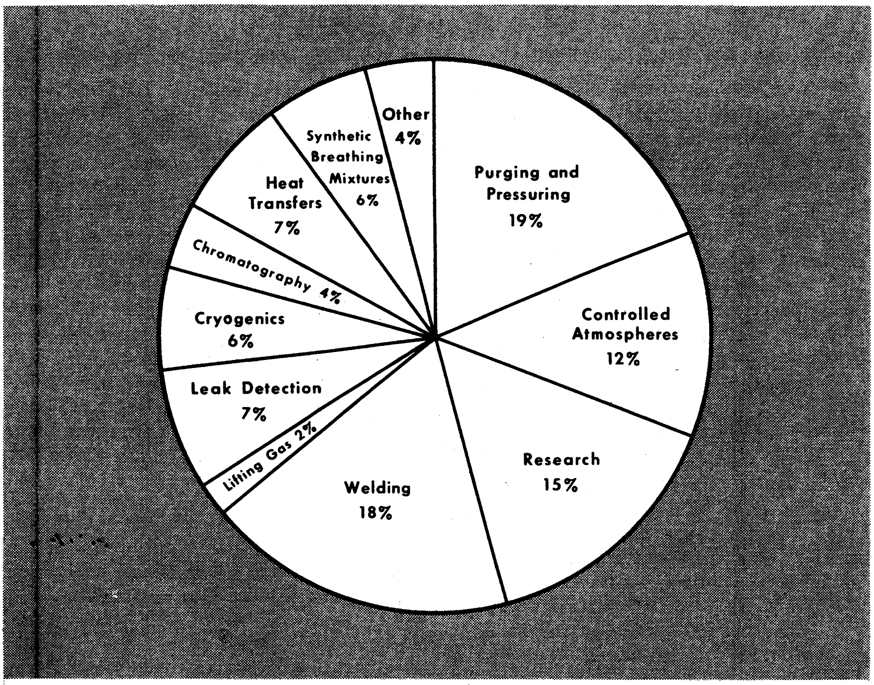

Figure 3.—Helium consumption by end use in the United States, 1975.

CONSERVATION

Helium held in the Bureau of Mines conservation storage system, which includes the conservation pipeline network as well as the Cliffside gasfield near Amarillo, Tex., increased about 1% during 1975. Of the 38,557 million cubic feet in storage at yearend, over 97% was held for the Bureau's conservation program, including that accepted under court order after March 28, 1971. The remaining amount was stored under contract for private companies.

The conservation storage system contains crude helium purchased by the Bureau of Mines under contracts entered into with four companies in 1961 and continued under court orders obtained during 1971 and 1973 by three of the companies.

Table 6.—Summary of Bureau of Mines helium conservation system [1] operations
(Thousand cubic feet)

	1973	1974	1975
Helium in conservation storage system at beginning of period:			
Stored under Bureau of Mines conservation program [2]	34,628,600	37,110,126	37,283,348
Stored under contract for private producers' own accounts	1,002,314	1,091,004	995,987
Total	35,630,914	38,201,130	38,279,335
Input to system:			
Net deliveries from Bureau of Mines plants [3]	188,245	173,222	186,435
Acquired from private industry conservation plants [2]	2,293,281	--	--
Stored under contract for private producers' own accounts	163,110	15,073	200,131
Total	2,644,636	188,295	386,566
Redelivery of helium stored under contract for private producers' own accounts	−74,425	−110,090	−108,531
Net addition to system	2,570,211	78,205	278,035
Helium in conservation storage system at end of period:			
Stored under Bureau of Mines conservation program [2]	37,110,126	37,283,348	37,469,783
Stored under contract for private producers' own accounts	1,091,004	995,987	1,087,587
Total	38,201,130	38,279,335	38,557,370

[1] Includes conservation pipeline system and Cliffside field.
[2] Includes helium accepted after Mar. 28, 1971, under court order.
[3] Excludes return to system of conservation helium produced from native gas withdrawal wells at Cliffside field which have been invaded by stored helium.

Table 7.—Deliveries and withdrawals of crude helium stored for private companies' own account in the Bureau of Mines conservation storage system, 1975
(Thousand cubic feet)

Owner	Plant location	Delivered	Withdrawn	Net
Cities Service Helex, Inc	Ulysses, Kans	10,274	6,504	3,770
National Helium Corp	Liberal, Kans	--	23,316	−23,316
Phillips Petroleum Co	Dumas, Tex	--	34,879	−34,879
Jack B. Kelley Co	Amarillo, Tex	49,774	16,080	33,694
Kansas Refined Helium Co	Otis, Kans	140,083	27,753	112,330
Total		200,131	108,532	91,599

RESOURCES

As of December 31, 1975, domestic measured and indicated helium resources were estimated at 233.5 billion cubic feet (in natural gas with a minimum helium content of 0.3%). These resources include measured and indicated helium reserves (minimum 0.3% helium) estimated at 103.3 and 41.8 billion cubic feet, respectively. The remaining resource base includes 38.6 billion cubic feet in the Bureau's conservation storage system and 49.8 billion cubic feet of helium in measured natural gas reserves with a helium content of less than 0.3%. About half of the domestic helium reserves are under Federal lease. Included are the Tip Top field in Wyoming, Keyes Field in Oklahoma, Cliffside in Texas, and the Church Buttes, Wyoming, field.

Most of the domestic helium reserves are located in the midcontinent region of the United States. A total of 86 gasfields in 10 States contain measured and indicated helium reserves. Five helium-bearing gasfields contain about 90% of domestic reserves. These fields are the Hugoton field in Kansas, Oklahoma, and Texas; the Tip Top field in Wyoming; the Keyes field in Oklahoma; and the West Panhandle and Cliffside fields in Texas. About 60% of the measured and indicated reserves at yearend were in currently producing fields. Approximately 13% of the helium-rich natural gas (minimum 0.3% helium) produced in 1975 was processed for helium extraction, while the helium contained in the remaining helium-rich natural gas output was dissipated incident to the consumption of the gas.

The Bureau of Mines continued its

efforts to survey and identify possible new domestic and foreign helium resources. A total of 360 natural gas samples from 21 States and 1 sample from Canada were collected and analyzed for helium content during 1975. None of the samples indicated the presence of major new deposits of helium. A preliminary study conducted in the Dineh de Keyah field in Apache County, Ariz., indicated that about 1.3 billion feet of recoverable helium may be present. Helium-containing natural gas was also studied in two reservoir formations. The natural gas in these reservoirs is not being produced because its caloric heat value is less than 50 British thermal units (Btu) per thousand cubic feet. The helium contents of the two reservoirs were determined to be 5.3% and 3.1%.

FOREIGN TRADE

Exports of high purity helium, all by private industry, increased about 12% in 1975 to 144 million cubic feet from 129 million cubic feet in 1974. A total of 76% of the exports were shipped to Europe, as follows: Belgium, 40%; the United Kingdom, 21%; France, 15%. Exports to Japan and Canada were 10% and 5%, respectively. The increase in exports to Western Europe in 1975 was attributed to the increased use of high purity helium in the exploration of oil and gas in that area, especially in the North Sea.

Table 8.—Exports of high purity helium from the United States
(Million cubic feet)

Year	Quantity
1971	r e 107
1972	r e 112
1973	r e 117
1974	r e 129
1975	[1] 144

e Estimate. r Revised.
[1] Bureau of the Census.

WORLD REVIEW

World production of helium, exclusive of the United States, was estimated at 146 million cubic feet in 1975. Canadian production was about 35 million cubic feet from a plant in Saskatchewan owned by Canadian Helium, Ltd. Production from a plant near Paris, France, was about 11 million cubic feet. The U.S.S.R. and countries of Eastern Europe produced an estimated 100 million cubic feet.

It was reported that hydrocarbons and helium were discovered at a depth of 20,843 feet in a well located on the Kola Peninsula near the Barents Sea, about 65 miles west of Murmansk, U.S.S.R. Reported plans called for deepening the wildcat to 23,830 feet.

During 1975, construction continued on a prototype helium extraction plant in Alberta Province, Canada. Plant design will utilize a diffusion technique for processing natural gas with a helium content from 0.05% to 0.70%. Full plant operation was scheduled for 1977, and completion cost was estimated to be about $300,000.

A joint venture by West German industry and Government has produced an experimental, closed-cycle helium turbine heating and generation plant, the first of its kind. The helium turbine in 1975 was undergoing further tests prior to commissioning. The venture is part of a research program to develop a nuclear, direct-cycle, helium-cooled, high-temperature electrical generation facility.

In early 1975, work and research continued on a natural gas upgrading and helium extraction plant at Odolanow, Poland. This plant is the first of its kind in Europe. Natural gas in the region has a methane content of 56% with a caloric value of about 580 Btu per thousand cubic feet, 43% nitrogen, and 0.4% helium. The nitrogen and helium are to be removed and the caloric value of the methane increased by a new process devised by Petrocarbon Developments, Ltd., of Manchester, United Kingdom. By this process, natural gas is fractionated in two, low-temperature distillation columns linked by a reboiler-reflex condenser. No heat pump cycle is used, thus resulting in a saving of energy and a reduction of machinery needs. The upgraded methane (980 Btu per thousand cubic feet) leaves the plant and enters the main transmission lines at 300 pounds per square inch without recompression. Overall hydrocarbon recovery will exceed 98%. The plant will also supply nitrogen purge gas and refrigeration for the recovery of helium. About 88% of the helium present in the natural gas is to be recovered. Full plant operation, processing approximately 6 billion cubic feet of gas per year, was scheduled for July 1976.

TECHNOLOGY

In October 1975, the U.S. Department of the Interior announced the development of a new helium "sniffer" device by the U.S. Geological Survey for detecting helium. The prospecting device is designed to measure microscopic amounts of helium gas in soils. Samples to be analyzed are obtained from a depth of 2 feet in the soil and transferred into a metal tube for analysis by the sniffer device. The Survey reported the device had been tested with good results over known geothermal resource areas containing high concentrations of helium. Also, in western Colorado and Utah, measurements indicated helium over several oil and uranium deposits. The sniffer can detect and measure helium concentrations in soil in amounts as small as 50 parts per million.

The Bureau of Mines developed an analytical procedure for determining the quantity of helium-3 in helium-4 in parts per billion range. Several university helium research laboratories in the United States and the United Kingdom had samples analyzed by the Bureau's equipment. The technique was developed as part of the Bureau's isotopically pure helium-4 project.

The use of helium as a tool in exploration for uranium is being studied by Martin-Marietta Aerospace and the U.S. Energy and Research Development Administration (ERDA). In theory, anomalous concentrations of helium produced by the radioactive decay of uranium are assumed to be associated with deep-seated uranium deposits. Plans call for testing helium and uranium by the sniffer measuring device in areas of known uranium ore bodies.

National Aeronautics and Space Administration (NASA) research had indicated a method for the conversion of fission energy directly into laser light by a nuclear-energized laser that contains helium. In the experiments, a reactor provided a neutron pulse to produce energetic fission fragments in a laser gas consisting of helium and xenon. These experiments point up the possibility of major advances in power transmission over long distances, energy conversion, and long-range communications.

Iron Ore

By F. L. Klinger [1]

World production of iron ore in 1975 was estimated at 880 million tons,[2] slightly below the level of 1974. World shipments of iron ore, however, were substantially less than in 1974 owing to a decline in demand for iron and steel. The leading producing countries continued to be the Soviet Union, Australia, the United States, and Brazil.

World exports of iron ore were estimated at approximately 375 million tons, of which an estimated 295 million tons were oceanborne. These totals were 6% less than in 1974. The leading exporting countries were Australia, Brazil, the Soviet Union, and Canada.

The reduced level of shipments resulted in large accumulations of ore stocks by several major producers, notably in Australia, Sweden, and Liberia. The relatively high level of stocks was expected to slow down production in 1976.

The major importing countries in 1975 continued to be Japan (129.6 million tons), the European Community (EC) (120 million tons), and the United States (46.7 million tons). Imports by Japan and West Germany in 1975 were 10 and 13 million tons, respectively, less than in 1974.

World output of iron ore pellets was estimated at 165 million tons in 1975. The United States continued to lead in production, with 62.5 million tons, followed by the Soviet Union (27 million tons), Canada (23.7 million tons), and Sweden and Australia with about 9 million tons each. Major additions to productive capacity were underway in the United States and Brazil, and new pelletizing plants were under construction or planned in at least 10 other countries.

Although production of prereduced ore grew slowly in 1975, direct reduction plants were under construction or contracted for in at least 10 countries.

Iron ore prices in 1975 were substantially higher than in 1974. These mainly resulted from rapidly rising costs of production and transportation. Ocean freight rates for iron ore continued to decline owing to the surplus of available ships and the decline in demand for ore, but rail and lake freight rates increased in the United States.

A major new iron mine (Mount Wright) began production in Canada during 1975, development of the Kudremukh deposits in India began, and the Sishen-Saldanha Bay project in the Republic of South Africa was nearing completion. Major investments in new mines and plants were being made in the United States and several other countries, but rising costs, as well as the depressed condition of iron ore markets, were making it difficult to find adequate financing for many proposed projects. There seemed to be little prospect of these conditions improving in 1976.

Increasing environmental controls have added significantly to the cost of iron ore mining projects, particularly in the United States. At yearend, it was uncertain whether Reserve Mining Co. would continue operations if required to shift its tailings disposal area farther north than proposed in 1974. The company had an annual production capacity of 10.7 million tons of iron ore pellets.

The Association of Iron Ore Exporting Countries (AIOEC) was formed in 1975. Member countries at yearend were Australia, Sweden, Peru, Chile, Mauritania, Venezuela, Algeria, Tunisia, Sierra Leone, and India. These countries accounted for about 26% of world production and 50% of world exports of iron ore in 1974. The long-range goal of the association appeared

[1] Physical scientist, Division of Ferrous Metals.

[2] The long ton of 2,240 pounds is the unit of weight used in this chapter, unless otherwise specified.

to be to obtain higher prices for iron ore, but the absence of orebuying nations from the group and the presence of large iron ore resources in nonmember countries was likely to inhibit such efforts.

The Government of Peru nationalized the iron mining properties of Marcona Mining Co. on July 25, 1975. Agreement on compensation was not reached by yearend; meanwhile, exports appeared to have ceased. The Peruvian action followed nationalization of Venezuelan mines, effective January 1, 1975, and similar actions in Mauritania (late 1974) and Chile (1971).

Table 1.—Salient iron ore statistics
(Thousand long tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Iron ore (usable,[1] less than 5% Mn):					
Production [2]	80,762	75,434	87,669	84,355	78,866
Shipments [3]	77,106	77,884	90,654	84,985	75,695
Value [3]	$891,001	$950,365	$1,163,710	$1,388,447	$1,620,599
Average value at mines per ton	$11.55	$12.20	$12.84	$16.34	$21.41
Exports	3,061	2,095	2,747	2,323	2,537
Value	$38,147	$26,776	$37,922	$35,148	$60,071
Imports for consumption	40,124	35,761	43,296	48,029	46,743
Value	$450,644	$415,934	$533,488	$696,298	$860,496
Consumption (iron ore and agglomerates)	116,196	126,943	146,922	138,160	114,126
Stocks Dec. 31:					
At mines	17,653	14,679	10,876	9,405	12,299
At consuming plants	57,738	50,061	45,990	45,247	52,231
At U.S. docks	3,424	2,612	3,053	3,272	4,614
Manganiferous iron ore (5% to 35% Mn): Shipments	177	131	181	r 244	142
World: Production	774,677	765,465	r 832,343	r 881,244	880,364

r Revised.
1 Direct shipping ore, concentrates, agglomerates, and byproduct ore (mainly pyrite cinder and agglomerates).
2 Includes byproduct ore.
3 Excludes byproduct ore.

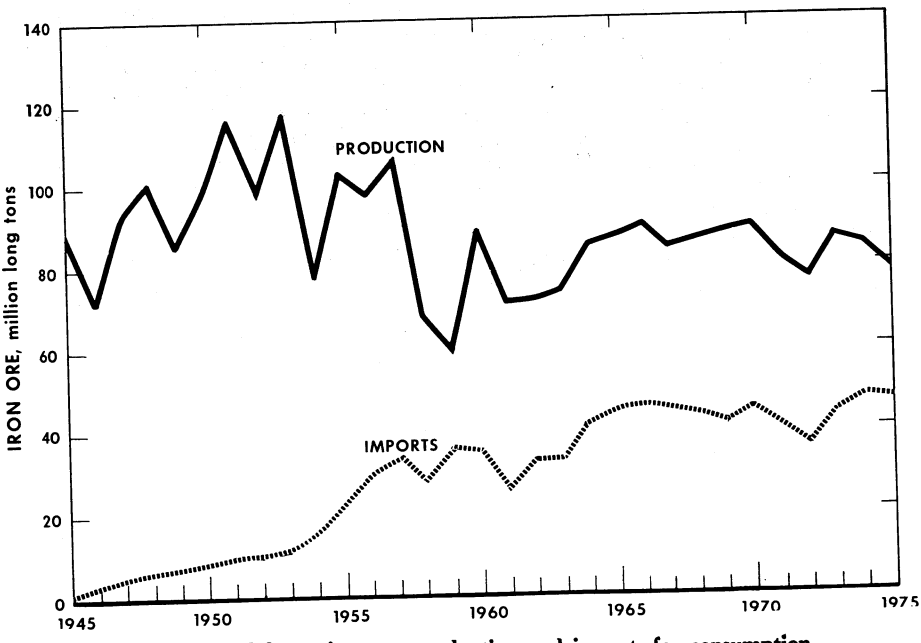

Figure 1.—United States iron ore production and imports for consumption.

EMPLOYMENT

Summary statistics on employment and productivity in the U.S. iron ore industry in 1975, as developed from data collected by the Mining Enforcement and Safety Administration (MESA), are shown in table 2.

The average number of persons employed (20,000) and the total hours worked (39.1 million) in 1975 were within 1% of the respective totals for 1974, but nationwide average productivity of usable ore declined about 6.5% due mainly to cutbacks in output of natural ore concentrates and direct-shipping ore from Minnesota mines and plants. In Michigan, employment and productivity increased in 1975 owing to the first full year of production at the Tilden mine, while in California, employment decreased due to curtailment of operations at the Beck mine.

The average number of persons employed in 1975 included approximately 11,000 engaged in mining and transport of crude ore, and 8,900 in beneficiation plants. Owing to variations in reporting practice, both of these figures include some repair and maintenance shop personnel. As in previous years, statistics published in table 2 do not include office workers. The number of office workers at mines and beneficiation plants in 1975 was approximately 2,600.

DOMESTIC PRODUCTION

U.S. mine production and shipments of iron ore in 1975 declined by 6.5% and 10.9%, respectively, compared with that of 1974. Shipments of ore from U.S. ports on the Great Lakes declined about 9%. The reductions were due to relatively low domestic demand for iron and steel in 1975.

Mine output of usable ore consisted about 80% of pellets and sinter, 18% of natural ore concentrates, and 2% of direct-shipping ore. Iron ore pellets made up more than 79% of the total output because production from natural ore mines, especially on the Mesabi range, was sharply reduced in 1975. Although fewer mines were active in the Southeastern and Western States during the year, production was reported from 3 additional small operations in Minnesota, so that the total number of producing mines in the United States (67) was 1 more than in 1974. The mines included 61 open pits and 6 underground operations.

Crude ore production in 1975 totaled about 215 million tons, 1% less than that of 1974. Open pit mines produced 96% of the total output, and 99% of the crude ore shipped was sent to beneficiation plants. The average iron content of all crude ore mined in 1975 was 33%, and the average iron content of all usable ore produced was 61.23%. Nationwide, the ratio of crude ore mined to usable ore produced was 2.72:1, compared with 2.57:1 in 1974. The relatively high ratio in 1975 was due to a larger proportion of taconite in total production compared with 1974.

The Lake Superior district accounted for nearly 85% of U.S. production of usable ore in 1975. Minnesota produced 65% of the national output, Michigan accounted for nearly 19%, and the remaining 16% was produced in 17 other States.

In Minnesota, construction of two new taconite mining operations and expansion of three others was well underway in 1975. Production from Hibbing Taconite Co. and the expansion project of Eveleth Taconite Co. was expected to start by the end of 1976. Production from the Minorca project of Inland Steel Co. and from expanded operations of United States Steel Corp. and the National Steel Pellet Project was expected to begin in 1977. Aggregate production capacity of new facilities for iron ore pellets will be 21 million tons annually in 1978. Early in 1975, Bethlehem Steel Corp. announced that production capacity of Hibbing Taconite Co. will be raised to 8.1 million tons annually, an increase of 2.7 million tons over the capacity originally planned. The latter expansion will be completed in 1979. Construction costs at these projects were revised upward in 1975 so that the total investment was expected to be $1 billion, an increase of $200 million over that anticipated in 1974.

While the above taconite projects will increase annual production capacity for pellets in Minnesota by nearly 24 million tons, the continuation of production by Reserve Mining Co., which has a production capacity of 10.7 million tons of pellets per year, was uncertain. Under a court order, Reserve will be required to shift its tailings disposal from Lake Superior to an onland site. The company's proposal to shift its discharge to a land site about 7 miles away from the concentrator ("Milepost 7"), at a cost of more than $240 million, had not been approved by State authorities by yearend. The State authorities suggested relocation to a more distant site, but the company said that this would increase the cost to at least $400 million, an amount which it considered prohibitive. Final decisions by the State and the company were possible in 1976.

In June 1975, the Minnesota Legislature raised the State's production tax on taconite concentrates (including pellets) by 39 cents per ton, retroactive to January 1, 1975. This more than doubled the production tax, which previously was about 36 cents per ton.

In Michigan, The Cleveland-Cliffs Iron Co. announced plans to increase production capacity for iron ore pellets at the Empire mine by 2.8 million tons annually by 1980. This will raise total output capacity of the operation to 8 million tons annually. The company was also considering expansion of the Tilden project to a production capacity of 8 million tons annually. The Tilden facility completed its first year of operation successfully in 1975.

In Alabama, production of brown ore concentrates at Russellville was suspended in September 1975 by United States Pipe and Foundry Co. The Russellville mine was the last operating iron mine in Alabama. Thirty-seven employees were affected.

In California, production of iron ore concentrate at the Beck mine in San Bernardino County was halted in late 1974 by Standard Slag Co. The concentrate had been produced since 1971 for export to Japan, at the rate of about 400,000 tons per year. In Pennsylvania, the iron ore pelletizing plant at Cornwall was reactivated in 1975 by Bethlehem Steel Corp. Feed for the plant was reportedly purchased concentrates.

CONSUMPTION

Total consumption of iron ore and agglomerates in 1975 was 17% less than in 1974. Consumption in steelmaking furnaces declined 27%, while consumption in blast furnaces was down 17%. Of total consumption, blast furnaces accounted for 98.3% and steel furnaces for 1.1%; the remaining 0.6% was used in the manufacture of cement, heavy-media materials, pigments, and other miscellaneous products. In blast furnaces, the weight ratio of iron ore and agglomerates consumed to pig iron produced was about 1.56:1 in 1975, compared with 1.57:1 in 1974.

Iron ore pellets made up 56% of all iron ore and agglomerates consumed in 1975, and 67% of all agglomerates consumed. These proportions were larger than in the previous 2 years.

Consumption statistics are shown in tables 11 and 12. In these tables, iron ore concentrate used to produce agglomerates such as pellets and sinter at mine sites is not reported as iron ore consumed; its consumption was reported only when such agglomerate was shipped to the furnace site and used (table 11). Iron ore concentrates and fines used to produce agglomerate such as sinter at iron and steelmaking plants is reported as iron ore consumed in table 12, and consumption of agglomerates from this source is included in table 11. In table 12, the difference in weight between iron ore consumed and agglomerate produced results from the elimination of moisture as well as the addition of materials such as flue dust, mill scale, lime, and coke.

STOCKS

Stocks of iron ore and agglomerates at U.S. mines, docks, and consuming plants totaled 69.1 million tons on December 31, 1975. This was an increase of 11.2 million tons or 19% compared with stocks on December 31, 1974, and was the highest yearend total since 1971. The lowest monthend level of stocks at U.S. consuming plants was 32.6 million tons in April 1975, compared with the record low of 24 million tons in April 1974. Of the 56.8 million tons on hand at U.S. docks and consuming plants at yearend, U.S. ores made up 57%, Canadian ores 17%, and other foreign ores 26%.

PRICES

Published prices for Lake Superior iron ores (delivered rail of vessel at lower lake ports) increased 6% to 7% during 1975. Prices for natural ores during the first 6 months of the year were unchanged from December 1974 levels, while the price of iron ore pellets quoted by different producers rose during the same period by 1.4% to 2.8%. In early July, prices for natural ores (basis 51.5% Fe, natural) increased by $1.22 per gross ton, and pellet prices increased 1.4 to 2.0 cents per long ton unit of contained iron, natural. The new prices, which remained in effect for the rest of the year, were as follows per long ton: Mesabi non-Bessemer, $18.50; Mesabi Bessemer, $18.65; Old Range non-Bessemer, $18.75; and manganiferous, $18.75. Iron ore pellets were 47.2 cents per long ton unit. Any increases in the cost of transportation and handling, subsequent to the announcement dates of the new prices (mostly July 3 to July 10), were to be borne by the buyer.

The average value (f.o.b. mine or concentrating plant) of usable iron ore shipped from domestic mines in 1975 was $21.41 per long ton, compared with $16.34 in 1974 and $12.84 in 1973. These values were calculated from producers' statements and approximated the commercial selling price less the cost of mine-to-market transportation.

Prices for Canadian and other foreign ores also increased in 1975, although prices under many Japanese contracts remained at levels set in late 1974. The price of Canadian (Wabush) iron ore pellets, f.o.b. vessel Pointe Noire, Quebec, was raised to 40.37 cents per unit of iron and manganese combined on January 2, 1975, and to 42.2 cents on September 29, 1975; the latter price was about 15% higher than in August 1974. The price of Quebec Cartier concentrates c.i.f. North Sea ports reportedly increased about 25% to $21.16 per metric ton in 1975.[3]

Swedish iron ore prices rose sharply in 1975. The major Swedish producers, Luossavaara-Kiirunavaara AB (LKAB) and Gränges AB, reported average increases in 1975 prices for most ore products of about 40% to 45% compared with 1974. LKAB reported increases in costs, however, of 37%. The price of Swedish high-phosphorus iron ore (Kiruna D, 60% Fe, 1.8% P), c.i.f. Rotterdam, was reported by Metallgesellschaft AG[4] at 80 Swedish kronor per metric ton on June 30, 1975, a rise of 38% from a year earlier. Under West German contracts for 1975, the f.o.b. price of Kiruna pellets (65% Fe) was equivalent to about 51 cents per metric ton unit of contained iron, and that of Kiruna B ore (about 65% Fe, 80% + 8 mesh) was equivalent to about 33 cents per metric ton unit. According to Gränges AB, prices for Liberian ores produced by the Lamco Joint Venture averaged about 45% more than in 1974.[5] The 1975 price of Nimba pellets, f.o.b. Buchanan, was about 46 cents per metric ton unit of contained iron, and for Nimba washed fines, 25.5 cents per metric ton unit.

The average price of Brazilian iron ore, 65% Fe, c.i.f. North Sea ports, was reported to be $20.10 per metric ton from January to June 1975, compared with $18.40 per metric ton (68% Fe) from July to December 1974.[6] The average f.o.b. value of Venezuelan iron ore exported to the United States, as indicated by U.S. Bureau of the Census data, was $15.63 per long ton in 1975, compared with $12.30 in 1974.

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[3] United Nations Committee for Trade and Development (UNCTAD), Geneva. Monthly Commodity Price Bulletin.

[4] Metallgesellschaft AG. Metal Statistics 1964–74. Frankfurt-Am-Main, Germany, 62d ed., 1975, p. 341.

[5] Granges AB. Annual Report for 1975. P. 12.

[6] International Bank for Reconstruction and Development. Commodity Trade and Price Trends. Report EC–166/75, August 1975, p. 86.

Some 1975 prices for iron ore under Japanese contracts are shown in the accompanying tabulation. All prices are free-on-board (f.o.b.), dry-long-ton (DLT) basis unless otherwise indicated:

Country, ore designation and grade	Approximate annual quantity (thousand tons)	Price
Australia:		
Whyalla pellets, 65.5% Fe	650	29.64 cents per 1% Fe.
Hamersley pellets, 63% Fe	2,200	30.0 cents per 1% Fe (effective July 1, 1975).
Savage River pellets, 66% to 67% Fe	2,000+	31.1 cents per 1% Fe.
Robe River pellets, 62.5% Fe	4,200	30.0 cents per 1% Fe.
Robe River fines, 56.5% Fe	2,600	14.2 cents per 1% Fe (effective Apr. 1, 1975).
Goldworthy sized lump, 64% Fe	3,000	22.18 cents per 1% Fe (effective Apr. 1, 1975).
Goldworthy fines, 64% Fe		18.36 cents per 1% Fe.
India:		
Chowgule pellets, 66% Fe	500	29.924 cents per 1% Fe (DMT basis).
Bailadila lump, 63% to 65% Fe (20% maximum-⅜")	6,000	$13.28 to $13.58 per DMT, f.o.b.t. Vizagapatnam.
Brazil:		
CVRD No. 3 contract, run-of-mine, 64% to 66% Fe	2,800	$13.90 per dry long ton (effective Apr. 1, 1975).
U.S.S.R.:		
Krivoi Rog fines, 55% to 57% Fe	1,000	$7.15 per DMT.
Krivoi Rog concentrates, 60% to 62% Fe		$7.95 per DMT.

DMT=dry metric ton f.o.b.t.=free on board, trimmed.

Source: The TEX Report Co. Ltd. (Tokyo). Iron Ore Manual 1975, pp. 99–214.

TRANSPORTATION

Iron ore shipments from U.S. ports on the Great Lakes during 1975 totaled 62.6 million tons, 9% less than in 1974. In addition, 17.6 million tons of ore was shipped during 1975 to destinations on the Great Lakes from Canadian ports, for a grand total of 80.2 million tons. Iron ore pellets made up approximately 80% of total shipments. These figures include shipments made during January, February, and March of 1975, which were an extension of the 1974 lake shipping season.

In March 1975, the first 12-month shipping season in the history of Great Lakes navigation was completed between Two Harbors, Minn., and lower lake ports. Icebreaking and other navigational aids were again used to extend the 1975 shipping season, and a second 12 month of ore shipping was achieved at Two Harbors in March 1976.

Statistics on shipments of iron ore from U.S. ports on the Great Lakes during the 1975 season (excluding shipments in early 1975 but including shipments in early 1976) are shown in the accompanying tabulation:

Port	Number of vessels loaded	Total tonnage shipped [1] (thousand long tons)	Average cargo (long tons)	Largest cargo (long tons)
Duluth, Minn	819	14,329	17,496	31,869
Taconite Harbor, Minn	377	9,979	26,469	57,404
Escanaba, Mich	502	8,949	17,827	32,643
Silver Bay, Minn	457	8,687	19,009	30,946
Two Harbors, Minn	306	8,225	26,878	53,423
Superior, Wis	322	6,423	19,949	30,313
Marquette, Mich	240	4,387	18,280	25,936
Total	3,023	60,979	XX	XX

XX Not applicable.
[1] Rounded to nearest 1,000 tons.

Source: Lake Carriers Association. Annual Report 1975, p. 41.

Statistics on receipts of iron ore at U.S. lower lake ports in 1974 are shown in the following tabulation (1975 data were not available):

Port	Thousand long tons [1]
Cleveland	13,959
Detroit	8,431
Indiana Harbor	8,292
Gary	7,496
Conneaut	6,877
South Chicago	6,550
Ashtabula	5,203
Toledo	4,872
Buffalo	4,766
Lorain	4,205
Burns Harbor	4,135
Huron	2,308
Total	77,094

[1] Rounded to nearest 1,000 tons.

Source: Lake Carriers Association, Annual Report 1975, p. 40, quoting U.S. Army Corps of Engineers, "Waterborne Commerce of the United States, 1974, Part III."

Lake freight rates for iron ore were increased January 1, 1975, as follows (per gross ton): From the head of the lakes to lower lake ports, $3.70; from Marquette, Mich., to lower lake ports, $3.05; from Escanaba, Mich., to Detroit and Lake Erie, $2.78; and from Escanaba to lower Lake Michigan ports, $2.22. These rates, which remained in effect through yearend 1975, were about 12% higher than those in effect during the last half of 1974. The additional charge for iron ore cargoes requiring more than 24 hours to unload, and for unloading at docks not capable of handling vessels of more than 23 feet draft, was unchanged at 25 cents per gross ton. Handling charges (car to vessel at upper lake ports, and rail of vessel to car or stockpile at lower lake ports) ranged from 39 cents to $1.10 per ton in 1975 and were about 15% higher than in 1974. The vessel freight rate from the Gulf of St. Lawrence to Lake Erie ports was unchanged at $1.70 per ton.

Construction of larger lake ore carriers and automation of unloading systems continued in 1975. Eight 1,000-foot self-unloading vessels, capable of carrying 59,000 gross tons of iron ore pellets at maximum draft, were under construction. The first of these carriers was expected to begin service in late 1976, three more in 1977, two in 1978, and two in 1979. Plans to build a 1,100-foot lake carrier were deferred pending authorization from the Corps of Engineers to allow passage of such vessels through the Poe lock at Sault Ste. Marie. During 1975, one self-unloading vessel with a cargo capacity of 24,000 tons of pellets was commissioned, three other vessels were lengthened to increase cargo capacity, and two vessels were converted to self-unloaders.

Burlington Northern Inc. awarded contracts to Arthur G. McKee & Co. in mid-1975 for construction of new shiploading and storage facilities for iron ore pellets at Superior, Wis. The facilities will be capable of loading 1,000-foot vessels, will have a total handling capacity of 18 million tons of pellets per year, and were planned for completion by the spring of 1977.

A disaster occurred on Lake Superior on the night of November 11, 1975. The 31,000-ton ore carrier *Edmund Fitzgerald* sank during a violent storm west of Coppermine Point, Ontario. All 29 crew members were lost.

Domestic rail freight rates for iron ore were increased in the fall of 1975. The increase for most routes was about 15% compared with rates in effect since December 1974, although the increases ranged from 7.7% (pellets from Marquette range to Escanaba, Mich.) to 21% (pellets from Nashwauk and Keewatin, Minn., to Duluth-Superior). In Ohio, Youngstown Sheet & Tube Co. was hauling iron ore pellets by truck from Ashtabula to Youngstown with a reported saving of $1 per ton compared with rail transport.

Ocean freight rates for iron ore continued to decline in 1975. The vessel freight rate from Sept-Iles, Quebec, to U.S. east coast ports (north of Hatteras) declined to $1.05 per ton in October, compared with $3.25 to $3.75 per ton earlier in the year. Rates from the Gulf of St. Lawrence to U.S. gulf coast ports dropped to $1.50–$1.75 per ton, from $3.10—$3.60. Spot fixtures reported by Metal Bulletin during 1975 indicated shipments of 60,000 to 90,000 tons from Sept-Iles and Port Cartier to West Europe, at $2.05 to $3.20 per ton, were $0.50 to $1 less than in 1974; shipments of 60,000 to 105,000 tons from Tubarão, Brazil, to West Europe were less than $4 per ton while shipments from Tubarão to Japan of 80,000 to 140,000 tons were less than $5 per ton; and shipments of 25,000 to 60,000 tons from Puerto Ordaz, Venezuela, to Western Europe were

$4 to $5 per ton. Fixtures from Tubarão to Baltimore for 48,000 to 60,000 tons were less than $4 per ton, while smaller shipments from Rio de Janeiro ranged from $8.75 per ton for 23,000 tons to Wilmington, N.C., to $6–$6.20 per ton for 30,000-ton cargoes to Contrecoeur, Quebec. From Liberia, rates of $3.20 to $3.30 per ton were indicated for shipments of 45,000 to 50,000 tons to U.S. east coast ports (north of Hatteras), and $2.30 to $3.50 per ton for shipments of 45,000 to 87,000 tons to West Europe. From Western Australia to Western Europe, rates of only $3.50 to $4.50 per ton were indicated for shipments of 125,000 to 150,000 tons ($2 to $3 less than in 1974), and $4.95 to $5.75 for shipments of 60,000 to 70,000 tons.

The largest individual cargoes of iron ore reported loaded at ocean shipping ports in 1975 were 265,302 long tons at Tubarão, Brazil; 258,000 tons at Sepetiba Bay, Brazil; 165,400 tons at Sept-Iles, Quebec; and 153,753 tons at Port Hedland, Australia. The largest cargoes continued to be unloaded at Japanese receiving ports; the largest shipment reportedly received in West Europe was 165,000 tons at Europoort in the Netherlands.

Pipeline transport of iron ore continued to increase, though slowly. A 31-mile slurry pipeline was commissioned in Mexico in 1975, and a 240-mile pipeline was under construction in Brazil. An estimated 3 million tons of iron ore concentrates were transported in slurry form in international trade in 1975.

The Suez Canal was reopened in mid-1975 after 8 years of closure. The event was not expected to have much effect on iron ore trade because of vessel size limitations (40,000 to 50,000 tons), relatively high insurance rates, and the canal's distance from most iron ore trade routes. It may prove convenient, however, for some ore shipments from India or the Republic of South Africa to Europe.

A disaster occurred in December 1975 when the Norwegian ore carrier *Berge Istra* sank in the Philippine Sea southwest of Mindanao. Of 31 crew members, only 2 survived. The vessel was carrying 188,000 tons of iron ore from Brazil to Japan.

FOREIGN TRADE

U.S. exports of iron ore in 1975 were 9% more than in 1974. Shipments to Canada accounted for all of the increase; exports to Canada in 1974 were lower than normal owing to a Canadian shipping strike in that year. Because of participation of Canadian steel companies in some new taconite mining operations in Michigan and Minnesota, exports to Canada are expected to increase during the next 5 years.

Exports to Japan declined sharply in 1975 owing to termination of the 5-year export contract between Standard Slag Co. and Nippon Steel Corp.

U.S. imports of iron ore for consumption totaled 46.7 million tons in 1975 and were the second highest on record. The principal supplying countries were Canada, with 41% of the total, followed by Venezuela (28%), Brazil (16%), and Liberia (5%). Imports from Brazil reached a record total of 7.5 million tons. Imports from Peru stopped in August, owing to nationalization of the operations of Marcona Mining Co. on July 26 and lack of agreement between the Peruvian Government and Marcona over compensation to be paid. Imports from Venezuela, where the properties of Orinoco Mining Co. and Iron Mines Co. of Venezuela had been nationalized on January 1, 1975, were 2.2 million tons less than in 1974. Compared with 1974, imports from Chile increased by 600,000 tons and imports from the Soviet Union doubled to 265,000 tons. New sources were India (164,000 tons) and the Republic of South Africa (128,000 tons).

The Philadelphia customs district continued to receive the largest share of imports (33%) with a record total of 15.3 million tons in 1975, followed by Baltimore (23%), Cleveland (12%), Mobile (9%), and Chicago (8.6%).

The average value of imported ore, f.o.b. country of origin, was $18.41 per ton in 1975 compared with $14.50 per ton in 1974. The average value of exported ore was $23.68 per ton, compared with $15.13 in 1974. The increase in average value of imports appeared to be due largely to a general increase in foreign iron ore prices, while the greater increase in average value of exports was due partly to the increased proportion of high-value pellets in 1975 exports.

World trade in iron ore in 1974 and 1975 is shown in tables 21 and 22.

WORLD REVIEW

Angola.—Cia. Mineira do Lobito reportedly suspended its mining operations in August 1975, presumably because of the civil war. Exports of iron ore in 1975, as indicated by trade data of the principal importing countries, totaled 2.6 million tons, or about half the quantity exported in 1974.

Argentina.—The Sierra Grande iron ore project, which is expected to supply 2 million tons of pellets per year for domestic consumption, was reported to be about 2 years behind schedule owing to delays in financing and equipment delivery. A 6-week strike by miners also affected the project in late 1975. Hierro Patagónico S.A. Minera (HIPASAM), the State operating company, hoped to begin "commercial production" in 1976.

Australia.—Production of iron ore in 1975 was slightly higher than in 1974, but exports declined to 79 million tons and accumulations of ore stocks were reported.

Pellet production in 1975 was estimated at 8.9 million tons, of which 8.5 million tons were exported. Production capacity for pellets was increased to 3 million tons per year by Hamersley Iron Pty. Ltd. and to 5 million tons per year by Cliffs Robe River Iron Associates.

Production capacity for iron ore was being increased by Mount Newman Mining Co. Pty. Ltd. to 40 million tons per year by July 1976. New production equipment added by the company included 13 Wabco 200-ton ore haulage trucks. The Hamersley Co. was planning to increase its productive capacity by about 6 million tons of ore per year, at a cost of $100 million, by beneficiating low-grade ("reject") materials at Mount Tom Price. The company's productive capacity in 1975, including that at the Paraburdoo mine, was about 40 million tons per year.

Plans to establish new iron ore mines in the Pilbara district of Western Australia continued to be announced in 1975, but firm completion dates for these projects were uncertain because the necessary contracts for ore sales were still being negotiated. Texasgulf Marandoo Ltd. planned to develop a mine 35 miles east of Mount Tom Price, with a production capacity of more than 10 million tons per year. Broken Hill Proprietary (BHP) announced plans to develop its Deepdale deposits, west of the Robe River development, for a production capacity of 15 million tons annually in the early 1980's. Together with previously announced plans by Goldsworthy Mining Ltd. to develop a mine between Mount Whaleback and Mount Tom Price, these projects would add at least 35 million tons of new production capacity to the Pilbara district by the early 1980's with an aggregate proposed investment of more than $1 billion.

The Hamersley Co. reported that operating costs per ton of ore produced increased 27% in 1975. During the last 3 years, unit costs have risen 70%, plant construction costs in the Pilbara district have risen almost 100%, and costs of providing and operating housing and other community facilities have risen even more steeply.[7]

The Australian Bureau of Mineral Resources was reported in 1975 to have revised estimates of iron ore reserves in Australia upward to 34 billion long tons, including about 25.8 billion tons of hematite ore containing 54% or more iron and 9.2 billion tons of limonitic ore containing 50% or more iron.[8]

Brazil.—Shipments of iron ore by Brazilian producers in 1975 were estimated at 79 million tons, including reported exports of 71 million tons. Shipments by Companhia Vale do Rio Doce (CVRD) totaled 55.7 million tons, of which 52.9 million tons was exported. About 16% of shipments and 13% of exports by CVRD were for the account of other companies. Shipments by Minerações Brasileiras Reunidas, S.A. (MBR) totaled 11.7 million tons in 1975, of which 10.4 million tons was exported. Most of the ore shipped by MBR (9.5 million tons) was produced at the recently opened Aguas Claras mine.

Shipments of iron ore pellets in 1975 by CVRD, the only producer, were 4.1 million

[7] Hamersley Holdings Ltd. Annual Report, 1975. Pp. 4, 9.
[8] Mining Journal (London). Mining Annual Review, 1976. June 1976, p. 364.

tons, including exports of 3.7 million tons. The pellets were produced in two plants at Tubarão. At least four additional pellet plants, with a total production capacity of 12 million tons per year, were under construction at Tubarão in 1975, and two more, with a combined capacity of 8 million tons, were scheduled to be built. Total pelletizing capacity at Tubarão was thus expected to be 25 million tons annually by 1979.

In other developments, Ferteco Mineração S.A. was increasing production capacity for ore products at the Fabrica mine in Minas Gerais to 5 million tons annually. Facilities to be installed by mid-1977 include a 2.5-million-ton-per-year pelletizing plant and a high-intensity magnetic concentrator. In addition to pellets, annual output will include about 1.25 million tons each of lump ore and sinter feed. Shipments from the Fabrica mine in 1975 consisted of about 1.1 million tons of lump ore and 2 million tons of fines.

A new iron ore mine and concentrator will be built near Belo Horizonte by Samarco Mineração S.A., to produce about 10 million tons of iron ore concentrates annually for export. A 240-mile pipeline will be built to transport the concentrate to the coast at Ponta Ubu, where half of the concentrate will be pelletized before shipment. Cost of the project was estimated at $400 million. The operating company was owned 51% by S.A. Mineração da Trindade (SAMITRI) and 49% by Marcona International S.A. Mining operations were planned to begin in 1977, but a completion date for the entire project was not announced.

The feasibility of exploiting iron ore deposits at Serra dos Carajás by 1980 was still uncertain at yearend. While a group of Japanese, Spanish, and British companies was reportedly interested in purchasing 25 million tons of ore annually, financing arrangements were still being sought. Cost of the project was estimated in 1975 at $2.7 billion.

Consumption of iron ore in Brazil in 1975 was estimated at 11 million tons, including 275,000 tons in direct-reduction plants.

Canada.—Production and exports of iron ore in 1975 declined 6% and 4% respectively, compared with 1974. Exports in 1975 totaled 35.5 million tons, of which about 54% was destined for the United States, 33% for EC countries, and 11% for Japan. Imports rose to nearly 4.8 million tons, partly because of a strike which sharply reduced shipments of iron ore pellets from Wabush mines during the year, and partly because of increased shipments of pellets from U.S. mines which are partly owned by Canadian companies. Consumption of iron ore in 1975 totaled 13 million tons, of which about 84% consisted of pellets. Total output of pellets by Canadian producers in 1975 was 23.7 million tons.

Production of iron ore concentrates at Mount Wright, Quebec, began in September 1975. Shipments were expected to begin in 1976. The Mount Wright project, owned and operated by Quebec Cartier Mining Co. (QCM), will have a production capacity of over 18 million tons of concentrate per year by 1977; this can be increased to 24 million tons per year if desired. Production from Mount Wright will replace production from Lac Jeannine, Quebec, where QCM has produced about 8 million tons of concentrate per year since 1964. Ore reserves at Lac Jeannine were expected to be exhausted in 1976.

QCM continued to develop the Fire Lake iron deposits for production in 1976. Ore from Fire Lake will be processed at the Lac Jeannine concentrator. Production of concentrate was scheduled to reach 6 million tons per year in 1977. All of the concentrate will be pelletized at Port Cartier by 1978, in a plant being built by a subsidiary of Dravo Corp. The plant will produce 3 million tons per year of pellets for blast furnace feed and 3 million tons of pelletized superconcentrate for direct reduction plants. This project was authorized by the Quebec Government in 1975, and will be owned 50.1% by the Government-controlled steel company, Sidbec-Dosco Ltd., 41.67% by British Steel Corp., and 8.23% by QCM.[9]

In other developments, Iron Ore Co. of Canada resolved a number of production problems at the Sept-Iles flotation and pelletizing plants and increased output to more than 3 million tons of pellets in 1975. The plant was designed to produce 6 million tons of pellets per year, us-

[9] Goodman, R. J. Iron Ore. Ch. in Canadian Minerals Yearbook for 1975. Department of Energy, Mines and Resources, Ottawa, 1976.

ing flotation concentrates produced from Schefferville hematite ores. At Bruce Lake, Ontario, Steel Co. of Canada Ltd. began production of sponge iron from Griffith mine pellets in 1975. The reduction plant was of the SL/RN type, fueled by Alberta coal. The first shipment of metallized pellets was reported in July. At Sudbury, Ontario, the direct-reduction plant formerly operated by Falconbridge Nickel Mines Ltd. was leased by Sudbury Metals Co., a company owned by Allis Chalmers (Canada) Ltd. and National Steel Corp. The plant will be modified to use a reduction process developed by Allis Chalmers, for the production of 1,200 tons of prereduced pellets per day beginning in 1976. In Labrador, the Newfoundland Government expropriated certain mineral properties of Canadian Javelin Ltd. that included 1.29 square miles of the Julian Lake iron ore deposits near Wabush. The reason given was that the company had not proceeded with due diligence to develop mining operations. This allegation was strongly denied by the company.

Canadian forecasts of iron ore shipments were for 67.5 million tons in 1980 and 105 million tons in 2000; these included exports of 55.9 and 83.6 million tons, respectively.

Finland.—The Raajärvi mine was closed by Rautaruukki Oy. in April 1975, owing to exhaustion of iron ore reserves. The mine produced 62,000 tons of concentrate during the year. Production of concentrate from the Rautavaara underground mine, which will replace output from Raajärvi, was 45,000 tons in 1975; full production will begin in 1976 at the rate of 500,000 tons annually. Production of byproduct iron ore pellets from the Mustavaara mine was also expected to begin in 1976. The Mustavaara ore will be mined primarily for its vanadium content.

Gabon.—The Government contracted in 1975 for construction of the trans-Gabon railroad. Completion of the railroad, which was expected by 1982, will provide access to a number of resources including the Belinga iron deposits.

Guinea.—The feasibility study for development of the Nimba iron deposits near the Liberian border, being conducted by LKAB of Sweden, was scheduled for completion in 1976. The Nimba deposits reportedly contain about 600 million tons of material with an average iron content of more than 60%.

India.—Production of iron ore was reported to be about 16% more than in 1974, but exports rose about 4% to 22.8 million tons in 1975.

Development of the Kudremukh iron deposits near India's west coast was begun in 1975, after agreement was reached between the Indian and Iranian Governments on details of the project. Iran advanced $130 million and will provide another $500 million in long-term credits. India agreed to supply Iran with 210 million tons of ore over a period of 28 years beginning in 1980.

A subsidiary of Chowgule and Co. Ltd. continued construction of a 1.8-million-ton-per-year pelletizing plant near the port of Mormugao. Completion of the plant was scheduled for late 1977. Virtually the entire output of the plant was contracted for by Japanese buyers through March 1988. The contracted price of the pellets through 1979 was 34.5 cents per dry metric ton unit of iron, f.o.b. Mormugao, with provision for renegotiation of price every 2 years.

Ivory Coast.—Kaiser Engineers and Constructors, Inc., was conducting preconstruction engineering studies on development of low-grade iron deposits in the Mount Klahoyo region, for Pickands Mather and Co. International. Proposed facilities include a 186-mile railroad, a port, and a pelletizing plant with production capacity of 12 million tons per year. The studies were to be completed March 31, 1976.

Korea, Republic of.—Under a contract signed in October 1975, Pohang Iron and Steel Co. Ltd. will receive 15 million tons of iron ore during a 10-year period beginning in 1976. The supplier will be Mount Newman Mining Co. Pty. Ltd. of Australia.

Liberia.—Exports of iron ore in 1975 totaled about 18 million tons, 28% less than in 1974. Stockpiles of ore products at Liberian mines and ports at yearend were estimated at 8 million tons.

Bong Mining Co. planned to invest $120 million to expand production capacity to 7.5 million tons per year by mid-1977. The project includes a pelletizing plant of 2.4 million tons' annual capacity, and expansion of the concentrator. Ore shipments by the company in 1975 totaled 5.4 million tons, including 1.7 million tons of pellets.

The Liberian American-Swedish Minerals Co. (LAMCO) planned to increase crude ore production at Mount Tokadeh to 7 million tons per year from the present level of 1.5 million tons. The company was also installing high-intensity magnetic separators and additional ball-milling capacity to its concentration plant. LAMCO produced 11.1 million tons of ore products in 1975, including about 2 million tons of pellets, but shipments (8.7 million tons) were the lowest since 1968.

LAMCO reserves of high-grade ore in the Nimba range, as of December 31, 1975, totaled about 120 million tons with an average iron content (dry basis) of 63%.[10]

Mexico.—The iron ore pelletizing plant of Consorcio Minero Peña Colorada S.A. at Manzanillo, on the west coast, began production in early 1975. Shipments of pellets totaled more than 1 million tons by yearend. Annual production capacity of the plant was 1.5 million tons. The plant receives concentrate through a 30-mile slurry pipeline from mines east of Manzanillo.

Shipments of iron ore pellets from Mexican plants in 1975 totaled more than 2.8 million tons, compared with 1.15 million tons in 1973.

Sierra Leone.—The Marampa mine operations of Sierra Leone Development Co. Ltd. were terminated at the end of October 1975. The principal owner, William Baird and Co. of the United Kingdom, said that the operation had been unprofitable for some time. The company had operated the mine since 1933.

Export shipments of iron ore from Sierra Leone totaled 1.2 million tons.

South Africa, Republic of.—Construction of the Sishen-Saldanha Bay mine, railway, and port project was nearing completion in 1975. Completion of the 530-mile railroad was expected in early 1976, and initial port facilities (for 100,000-deadweight-ton vessels) by late 1976.

Associated Manganese Mines of South Africa, Ltd. (ASSOMAN) contracted to export 3 million tons of iron ore per year to United States Steel Corp. for 15 years beginning in 1978. U.S. Steel acquired a 19% interest in ASSOMAN in 1975.

Sweden.—Production and exports of iron ore in 1975 declined by 15% and 30% respectively, compared with 1974. Exports totaled 22.7 million tons in 1975. Stocks of ore at Swedish mines increased by 5 million tons during the year; stocks at shipping ports also increased, and LKAB reported that an additional 1 million tons of ore was shipped for stockpiling at continental ports.

LKAB planned to rebuild the pelletizing plant at Kiruna to improve production and environmental controls. Changes in the Svappavaara plant were also planned. Production capacity for pellets was expected to increase by about 800,000 tons annually. LKAB produced 7.1 million tons of pellets in 1975, about 28% of total output of ore products. The company was also raising production capacity of the high-grade magnetite concentration line at Malmberget to 500,000 tons per year.

U.S.S.R.—Exports of iron ore in 1975 were 42.9 million tons, about the same as in 1974. Exports to east European countries, mostly Czechoslovakia and Poland, were estimated at about 38 million tons, and more than 4 million tons were shipped to Japan, Italy, and other western countries.

Crude iron ore production in 1975 was 464 million tons, from which 229 million tons of usable ore was produced. Average grade of usable ore was 59% Fe. The ratio of crude ore mined to usable ore produced was 2.03:1 in 1975, compared with 1.82:1 in 1970 and 1.34:1 in 1960. Pellet production in 1975 was approximately 27 million tons. Allis Chalmers Corp. expected to complete construction of the Kremenchug pellet plant in 1978. The plant will have a production capacity of 6 million tons of pellets per year.

Venezuela.—Nationalization of the mines took effect on January 1, 1975, the first year that the iron ore industry was under Government ownership. Under agreements with the former owners, Orinoco Mining Co. and Iron Mines Co. of Venezuela, the latter companies operated the facilities for the Government.

Production and exports of iron ore in 1975 declined by 6% and 17%, respectively, compared with 1974. Exports totaled 21.1 million tons; an estimated 62% went to the United States and most of the remainder went to EC countries.

[10] Liberian Iron Ore Ltd. Annual Report, 1975. P. 8.

Production of prereduced ore (high-iron briquets) at the Puerto Ordaz reduction plant in 1975 was 206,000 metric tons, with an average iron content of 84.7%. At Ciudad Guayana, construction of two direct-reduction plants with a total production capacity of about 700,000 metric tons per year were scheduled for completion in 1976. A third plant, with annual capacity of 400,000 metric tons per year using the Fior process, was to be completed at Matanzas in 1977. In 1975, contracts were let for six additional plants—three using the HyL process and three using the Midrex process—to be constructed at Ciudad Guayana by 1979. All of these plants will be fueled by natural gas. Total output capacity of the plants by 1979 was expected to be 5.3 million metric tons annually.

TECHNOLOGY

Technological trends in iron ore mining and beneficiation in 1975 continued along the lines of increasing the scale of mining operations; increasing size and productive capacity of mining, beneficiation, and transport equipment; improved instrumentation and use of computers, especially in mine scheduling and beneficiation process control; concentration of low-grade nonmagnetic ores by flotation and high-intensity magnetic separation; increased sizing and pelletization of ores; and increasing use of direct-reduction plants.

Evident worldwide in 1975 was the increased use of rotary drills for blastholes of 12- to 17½-inch diameter (with the larger diameters commonly used in taconite mining), of electric shovels with dipper capacities of 12 to 16 cubic yards, and of trucks with haulage capacities of more than 100 tons. Thirteen Wabco 200-ton trucks were being used for mining operations of Mt. Newman Mining Co. Pty. Ltd. in Australia; this is the only fleet of trucks of this size known to be used in iron ore mining, although a few 180-ton units have undergone production tests, and one 312-ton unit was being used at the Eagle Mountain mine in California in 1975.

Some open pit mines with production capacities for crude ore of 30 to 50 million tons annually were operating in Australia, Brazil, Canada, the United States, and probably the U.S.S.R. in 1975. The larger mines in the latter three countries produce low-grade ores of the taconite type.

Larger grinding mills were being installed. The ball mills for the expansion project of Eveleth Taconite Co., thought to be the world's largest, were 17 feet in diameter by 42 feet long. Six autogenous mills being installed at the concentrator of Hibbing Taconite Co. in late 1975 were 36 feet in diameter. The concentrator at Mount Wright, Quebec, which began production in 1975, is equipped with six 32-foot autogenous mills. The Mount Wright plant is reported to be highly automated and is divided into 90 sections for convenience of computer sequencing of starting and stopping.

Commercial production of iron ore superconcentrates was increasing. In Missouri, pellets produced in 1975 by Meramec Mining Co. at Pea Ridge averaged 67.5% Fe and 1.97% SiO_2. The use of high-intensity magnetic separators (HIMS) for production of high-grade concentrates from hematite ores was also increasing. At Itabira, Brazil, 1 million tons of specular hematite fines (−100 mesh) are being concentrated by HIMS to a product containing less than 1.5% SiO_2; the concentrate will be used in direct-reduction plants. At Port Cartier, Quebec, a plant being built to process Fire Lake concentrate for Sidbec-Dosco Ltd. will produce about 3 million tons of superconcentrate from −14-mesh spiral concentrate; pilot plant tests reportedly produced a concentrate containing 68.7% Fe and 1.45% SiO_2 with a 96.3% recovery. The Port Cartier plant will use Jones-type separators.[11] HIMS units were also being installed at the LAMCO concentrator in Liberia, to improve iron recovery and to increase the quantity of pellet feed produced.

Interest in low-silica superconcentrates was primarily in their use, after conversion to sponge iron in direct-reduction plants, as feed for electric steel furnaces and as a substitute for scrap.

Construction of many direct-reduction plants was underway or planned in 1975, mainly in fuel-rich countries. The availability of local supplies of high-grade iron

[11] Mining Journal (London). Mining Annual Review, 1976, p. 229.

ore was advantageous but not a necessary condition; in countries such as Qatar, Egypt, and Iran, reduction plants were being built which would be fed by imported ores. In countries having abundant resources of iron ore as well as natural gas, such as the U.S.S.R. and Venezuela, direct-reduction projects were larger. In Venezuela, annual production capacity for prereduced ore was expected to reach more than 5 million tons by 1979. Direct-reduction plants in North and South America produced about 2.2 million metric tons of prereduced ore in 1975, consuming an estimated 3.2 million tons of iron ore. Mexico accounted for about 40% of the total output; the United States, 24%; Canada, 16%; Brazil and Venezuela, about 10% each.

Preheating of prereduced iron ore, using waste heat from electric arc steelmaking furnace gases, was investigated by the Bureau of Mines. It was concluded that such preheating can lower electrical energy requirements by as much as 15%.[12]

With expected shortages of natural gas and rising costs of oil, new pelletizing plants in the Lake Superior district were being equipped to burn pulverized coal as well as oil or gas. Iron ore producing companies were conducting commercial-scale tests on the utility of various coals for pellet induration. The Bureau of Mines investigated the possible use of lower grade coal or lignite from the Western United States. The Bureau found that the ash fusion temperature of coal was a limiting factor. If the ash fusion temperature is lower than the temperature required for pellet induration, ring buildup tends to occur in the kiln, and production problems ensue.[13] Low ash fusion temperatures were found in most of the western coal studied.

Beneficiation of nonmagnetic taconite from the western Mesabi range continued to be investigated by the Bureau of Mines. Methods used included selective flocculation-desliming of the pulp, followed by flotation; magnetizing roast, followed by magnetic separation and flotation; and high-intensity wet magnetic separation. Detailed petrographic studies were used to supplement the research. These investigations were continued into 1976.

Methods of chemical analysis for taconite and other iron-bearing materials were described by a Bureau publication. The methods were suitable for a high volume of samples, and where instrumental results must be verified.[14]

An electric ironmaking process developed by McDowell Wellman Engineering Co. was said to be capable of utilizing a wide variety of low-grade iron-bearing materials (including low-grade ores and tailings) and carbonaceous fuels. A mixture of iron-bearing material, carbonaceous material, and flux is ground, pelletized, and fed onto a traveling grate where partial reduction takes place before the material is fed into an electric arc furnace. The process was said to offer savings in capital and operating costs over the blast furnace, and to produce very little liquid or gaseous effluents.[15]

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[12] Tress, J. E., W. L. Hunter, and W. A. Stickney. Continuous Charging and Preheating of Prereduced Iron Ore. BuMines RI 8004, 1975, 10 pp.

[13] Frommer, D. W. The Bureau of Mines Looks at Coal Firing for Induration of Iron Ore Pellets. Part 1. Low Rank Coal as a Fuel for Pellet Induration. Skillings' Min. Rev., v. 64, No. 16, Apr. 19, 1975, pp. 1–15.

Nigro, J. C. The Bureau of Mines Looks at Coal Firing for Induration of Iron Ore Pellets. Part 2. Coal Fired Pellet Induration Study. Skillings' Min. Rev., v. 64, No. 17, Apr. 26, 1975, pp. 1–15.

[14] Westbrook, W. T., R. H. Jefferson, and A. L. Birr. Wet Chemical Methods for Analyzing Taconite, Iron Ore, and Metallurgical Products. BuMines RI 8665, 1975, 30 pp.

[15] Skillings' Mining Review, v. 64. No. 36, Sept. 6, 1975, pp. 10–13.

Table 2.—Employment at iron ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, by district and State, in 1975

District and State	Average number of men employed (thousands)	Man-hours (thousands)	Crude ore (thousand long tons)	Usable ore (thousand long tons)	Iron contained [1] (thousand long tons)	Percent (natural)	Average tons per man-hour		
							Crude ore	Usable ore	Iron tained con-
Lake Superior:									
Michigan	4	7,703	39,788	14,774	9,327	63.1	5.17	1.92	1.21
Minnesota	11	22,110	143,296	51,177	31,004	60.6	6.48	2.31	1.40
Wisconsin	(2)	418	2,285	784	507	64.7	5.47	1.88	1.22
Total or average [3]	15	30,230	185,369	66,735	40,838	61.2	6.13	2.21	1.35
Southeastern States: Alabama and Georgia	(2)	59	384	139	66	47.5	6.46	2.34	1.11
Northeastern States: New York and Pennsylvania	1	2,263	5,171	1,860	1,201	64.6	2.28	.82	.53
Western States:									
Missouri, Montana, Nevada, Utah, Wyoming	2	3,877	12,912	5,793	3,603	62.2	3.33	1.49	.93
Other western States [4]	1	2,683	10,686	3,850	2,273	59.0	3.98	1.44	.85
Total or average [3]	4	6,560	23,598	9,643	5,876	60.9	3.60	1.47	.90
Grand total or average [3]	20	39,113	214,522	78,378	47,980	61.2	5.48	2.00	1.23

[1] Excludes byproduct ore.
[2] Less than ½ unit.
[3] Data may not add to totals shown because of independent rounding.
[4] Includes Arizona, California, Colorado, New Mexico, South Dakota, and Texas.

Table 3.—Crude iron ore mined in the United States, by district, State, and variety

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	1974 Number of mines	1974 Hematite	1974 Limonite	1974 Magnetite	1974 Total quantity [1]	1975 Number of mines	1975 Hematite	1975 Limonite	1975 Magnetite	1975 Total quantity [1]
Lake Superior:										
Michigan	6	W	--	W	27,638	6	W	--	W	39,788
Minnesota	27	31,828	--	121,966	153,794	30	20,029	--	123,267	143,296
Wisconsin	1	--	--	2,511	2,511	1	--	--	2,285	2,285
Total reportable	34	31,828	--	124,477	183,943	37	20,029	--	125,552	185,369
Southeastern States:										
Alabama and Georgia	4	--	r 644	--	644	3	--	384	--	384
Northeastern States:										
New York and Pennsylvania	3	--	--	6,991	6,991	3	--	--	5,171	5,171
Western States:										
Missouri	2	--	--	3,710	3,710	2	--	--	4,174	4,174
Montana	2	--	--	30	30	2	--	--	18	18
Nevada	3	W	--	W	139	3	W	--	W	106
Utah	3	W	--	W	3,663	4	W	--	W	3,544
Wyoming	3	W	--	W	4,983	2	W	--	W	5,070
Other [2]	12	r 54	r 3,030	r 10,028	13,112	11	109	2,323	8,254	10,686
Total reportable	25	r 54	r 3,030	r 13,768	25,636	24	109	2,323	12,446	23,598
Total withheld	--	r 12,435	--	r 23,988	(3)	--	20,920	--	27,588	(3)
Grand total [1]	66	44,317	3,674	169,223	217,214	67	41,058	2,707	170,757	214,522

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Total withheld" and "Total quantity."
[1] Data may not add to totals shown because of independent rounding.
[2] Includes Arizona, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.
[3] Total withheld data included with "Total quantity" for each respective district or State.

Table 4.—Crude iron ore mined in the United States, by district, State, and mining method

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	1974			1975		
	Open pit	Underground	Total quantity[1]	Open pit	Underground	Total quantity[1]
Lake Superior:						
Michigan	25,395	2,243	27,638	37,746	2,042	39,788
Minnesota	153,794	--	153,794	143,296	--	143,296
Wisconsin	2,511	--	2,511	2,285	--	2,285
Total reportable	181,700	2,243	183,943	183,327	2,042	185,369
Southeastern States:						
Alabama and Georgia	644	--	644	384	--	384
Northeastern States:						
New York and Pennsylvania	W	W	6,991	W	W	5,171
Western States:						
Missouri	--	3,710	3,710	--	4,174	4,174
Montana	30	--	30	18	--	18
Nevada	139	--	139	106	--	106
Utah	3,663	--	3,663	3,544	--	3,544
Wyoming	W	W	4,983	W	W	5,070
Other[2]	13,112	--	13,112	10,686	--	10,686
Total reportable[1]	16,944	3,710	r 25,636	14,354	4,174	23,598
Total withheld	8,993	2,981	(3)	7,677	2,564	(3)
Grand total[1]	208,281	8,934	217,214	205,743	8,779	214,522

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Total withheld" and "Total quantity."

[1] Data may not add to totals shown because of independent rounding.

[2] Includes Arizona, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.

[3] Total withheld data included with "Total quantity" for each respective district or State.

Table 5.—Crude iron ore shipped from mines in the United States, by district, State, and disposition

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	1974			1975		
	Direct to consumers	To beneficiating plants	Total quantity[1]	Direct to consumers	To beneficiating plants	Total quantity[1]
Lake Superior:						
Michigan } Minnesota	3,170	178,706	27,760	348	174,922	39,600
			154,116			135,670
Wisconsin	--	2,511	2,511	--	2,285	2,285
Total reportable	3,170	181,217	184,387	348	177,207	177,555
Southeastern States:						
Alabama and Georgia	--	712	712	--	384	384
Northeastern States:						
New York and Pennsylvania	--	6,807	6,807	--	4,328	4,328
Western States:						
Missouri	--	3,683	3,683	--	4,195	4,195
Montana	30	--	30	18	--	18
Nevada	139	--	139	106	--	106
Utah	W	W	3,669	W	W	3,535
Wyoming	W	W	4,983	W	W	5,070
Other[2]	310	12,729	13,039	274	10,757	11,031
Total reportable	479	16,412	25,543	398	14,952	23,956
Total withheld	1,339	7,314	(3)	998	7,608	(3)
Grand total[1]	4,987	212,463	217,449	1,745	204,478	206,223

W Withheld to avoid disclosing individual company confidential data; included with "Total withheld" and "Total quantity."

[1] Data may not add to totals shown because of independent rounding.

[2] Includes Arizona, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.

[3] Total withheld data included with "Total quantity" for each respective district or State.

Table 6.—Usable iron ore produced in the United States, by district, State, and variety
(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	1974 Hematite	1974 Limonite	1974 Magnetite	1974 Total quantity [1]	1975 Hematite	1975 Limonite	1975 Magnetite	1975 Total quantity [1]
Lake Superior:								
Michigan	W	--	W	11,339	W	--	W	14,774
Minnesota	17,318	--	41,167	58,484	10,466	--	40,711	51,177
Wisconsin	--	--	899	899	--	--	784	784
Total reportable [1]	17,318	--	42,066	70,723	10,466	--	41,495	66,735
Southeastern States: Alabama and Georgia	--	r 287	--	287	--	139	--	139
Northeastern States: New York and Pennsylvania	--	--	2,358	2,358	--	--	1,860	1,860
Western States:								
Missouri	--	--	1,862	1,862	--	--	2,299	2,299
Montana	--	--	30	30	--	--	18	18
Nevada	W	--	W	139	W	--	W	106
Utah	W	--	W	1,850	W	--	W	1,331
Wyoming	W	--	W	2,105	W	--	W	2,039
Other [2]	r 53	r 711	3,746	4,510	109	600	3,142	3,850
Total reportable	r 53	r 711	5,638	10,496	109	600	5,459	9,643
Total withheld	r 6,681	r --	8,751	--	8,670	--	9,581	(3)
Total all States [1]	24,052	998	58,813	83,863	19,244	739	58,395	78,378
Byproduct ore [4]	--	--	--	492	--	--	--	487
Grand total [1]	24,052	998	58,813	84,355	19,244	739	58,395	78,866

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Total withheld."
[1] Data may not add to totals shown because of independent rounding.
[2] Includes Arizona, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.
[3] Total withheld data included with "Total quantity" for each respective district or State.
[4] Including magnetite and residues from iron sulfides produced from base metal mines.

Table 7.—Usable iron ore produced in the United States, by district, State, and type of product

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	1974 Direct shipping ore	1974 Agglomerates	1974 Concentrates	1974 Iron content (natural, percent)	1975 Direct shipping ore	1975 Agglomerates	1975 Concentrates	1975 Iron content (natural, percent)
Lake Superior:								
Michigan	3,063	{10,735	15,082	63	386	{14,287		63
Minnesota		40,944}		60		40,711}	10,566	61
Wisconsin	--	899	--	65	--	784	--	65
Total reportable	3,063	52,578	15,082	61	386	55,782	10,566	61
Southeastern States: Alabama and Georgia	--	--	287	47	--	--	139	47
Northeastern States: New York and Pennsylvania	--	W	W	65	--	W	W	64
Western States:								
Missouri	--	1,828	34	66	--	2,269	30	67
Montana	30	--	--	42	18	--	--	50
Nevada	139	--	--	60	106	--	--	60
Utah	W	--	W	56	W	--	W	57
Wyoming	W	W	W	61	W	W	W	61
Other [1]	310	W	W	60	274	W	W	59
Total reportable	479	1,828	34	60	398	2,269	30	66
Total withheld	1,339	6,419	2,754	61	998	5,066	2,744	60
Total all States [2]	4,880	60,825	18,158	61	1,783	63,117	13,480	61
Byproduct ore [3]	--	(4)	492	64	--	(4)	487	63
Grand total [2]	4,880	60,825	18,650	61	1,783	63,117	13,967	61

W Withheld to avoid disclosing individual company confidential data; included with "Total withheld."

[1] Includes Arizona, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.

[2] Data may not add to totals shown because of independent rounding.

[3] Including magnetite and residues from iron sulfides produced from base metal mines.

[4] Byproduct agglomerates included with concentrates to avoid disclosing individual company confidential data.

Table 8.—Shipments of usable iron ore from mines in the United States, in 1975

(Thousand long tons and thousand dollars exclusive of ore containing 5% or more manganese)

District and State	Gross weight of ore shipped: Direct shipping ore	Gross weight: Agglomerates	Gross weight: Concentrates	Gross weight: Total quantity [1]	Total value [1]	Iron content of ore shipped: Direct shipping ore	Iron content: Agglomerates	Iron content: Concentrates	Iron content: Total quantity [1]
Lake Superior:									
Michigan	348	13,677	10,616	14,089	339,113	180	8,547	5,575	8,770
Minnesota		38,615		49,167	1,015,272		24,267		29,799
Wisconsin	--	791	--	791	W	--	512	--	512
Total reportable [1]	348	53,083	10,616	64,047	1,354,385	180	33,326	5,575	39,081
Southeastern States:									
Alabama and Georgia	--	--	164	164	1,163	--	--	77	77
Northeastern States:									
New York and Pennsylvania	--	W	W	1,924	47,887	--	W	W	1,227
Western States:									
Missouri	--	2,242	31	2,273	W	--	1,490	21	1,511
Montana	18	--	--	18	W	10	--	--	10
Nevada	106	--	3	109	1,017	64	--	2	66
Utah	998	--	337	1,334	10,399	575	--	186	761
Wyoming	--	W	W	2,039	26,792	--	W	W	1,242
Other [2]	274	W	W	3,786	86,664	163	W	W	2,216
Total reportable [1]	1,396	2,242	371	9,559	124,872	812	1,490	209	5,806
Total withheld	--	4,858	2,617	(3)	92,293	--	3,034	1,489	(3)
Total all States [1]	1,745	60,183	13,768	75,695	1,620,599	991	37,850	7,350	46,191
Byproduct ore [4]	--	[5]272	--	272	6,940	--	[5]172	--	172
Grand total [1]	1,745	60,455	13,768	75,967	1,627,540	991	38,022	7,350	46,363

W Withheld to avoid disclosing individual company confidential data; included with "Total withheld."

[1] Data may not add to totals shown because of independent rounding.

[2] Includes Arizona, Arkansas, California, Colorado, Idaho, New Mexico, South Dakota, and Texas.

[3] Total withheld data included with "Total quantity" for each respective district or State.

[4] Including magnetite and residues from iron sulfides produced from base metal mines.

[5] Includes small quantities of concentrates.

Table 9.—Usable iron ore produced in Lake Superior district, by range

(Thousand long tons and exclusive after 1905 of ore containing 5% or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Spring Valley	Black River Falls	Total [1]
1854–1970	390,098	306,038	320,334	103,528	2,776,526	70,336	8,149	844	3,975,851
1971	9,495	2,424	--	--	51,283	--	--	832	64,034
1972	9,131	2,533	--	--	48,998	--	--	888	61,550
1973	9,036	2,404	--	--	60,021	--	--	956	72,416
1974	8,920	2,419	--	--	58,484	--	--	899	70,723
1975	12,443	2,331	--	--	51,177	--	--	784	66,735
Total	439,123	318,149	320,334	103,528	3,046,489	70,336	8,149	5,203	4,311,309

[1] Data may not add to totals shown because of independent rounding.

Table 10.—Average analyses of total tonnage [1] of all grades of iron ore shipped from the U.S. Lake Superior district

Year	Quantity (thousand long tons)	Content, percent [2] Iron	Phosphorus	Silica	Manganese	Alumina	Moisture
1971	61,776	60.06	0.039	7.08	0.33	0.59	4.09
1972	64,721	60.40	.031	6.76	.30	.52	3.93
1973	76,281	60.66	.030	6.77	.33	.41	3.79
1974	72,194	60.26	.030	6.68	.35	.40	3.94
1975	64,174	60.91	.030	6.72	.28	.39	3.53

[1] Railroad weight—gross tons.
[2] Iron and moisture on natural basis; phosphorus, silica, manganese, and alumina on dried basis.
Source: American Iron Ore Association, Iron Ore, 1975, p. 92.

Table 11.—Consumption of iron ore and agglomerates in the United States in 1975
(Thousand long tons and exclusive of ore containing 5% or more manganese)

State	Iron ore and concentrates [1]		Agglomerates [2]		Miscellaneous [3]	Total reportable
	Blast furnaces	Steel furnaces	Blast furnaces	Steel furnaces		
Alabama, Kentucky, Texas	2,135	W	7,148	W	W	9,283
California, Colorado, Utah	1,267	W	5,392	W	W	6,659
Ohio and West Virginia	3,753	W	18,857	W	W	22,610
Illinois and Indiana	1,372	W	28,220	W	W	29,592
Michigan	219	W	9,435	W	W	9,654
Maryland, New York, Pennsylvania	8,792	W	25,597	W	W	34,389
Undistributed	--	541	--	663	734	1,938
Total [4]	17,539	541	94,649	663	734	114,126

W Withheld to avoid disclosing individual company confidential data, included with "Undistributed."
[1] Not including pellets or other agglomerated products.
[2] Includes 53,239,910 tons of pellets produced at U.S. mines and 10,661,992 tons of foreign pellets and other agglomerates.
[3] Includes iron ore consumed in production of cement and ferroalloys, and iron ore shipped for use in manufacture of paint, ferrites, and heavy media.
[4] Data may not add to totals shown because of independent rounding.

Table 12.—Iron ore consumed in production of agglomerates at iron and steel plants in 1975, by State
(Thousand long tons)

State	Iron ore consumed [1]	Agglomerates produced
Alabama, Kentucky, Texas	2,987	3,489
California, Colorado, Utah	1,893	2,087
Ohio and West Virginia	2,032	3,340
Illinois, Indiana, Michigan	6,381	8,268
Maryland, New York, Pennsylvania	9,733	13,055
Total [2]	23,026	30,239

[1] Includes domestic and foreign ores.
[2] Data may not add to totals shown because of independent rounding.

Table 13.—Beneficiated iron ore shipped from mines in the United States [1]
(Thousand long tons and exclusive of ore containing 5% or more manganese)

Year	Beneficiated ore	Total iron ore	Proportion of beneficiated to total (percent)
1971	70,456	77,106	91.4
1972	72,011	77,884	92.5
1973	86,894	90,654	95.9
1974	79,995	84,985	94.1
1975	73,951	75,695	97.7

[1] Beneficiated by further treatment than ordinary crushing and screening. Excludes by-product ore.

Table 14.—Production of iron ore agglomerates[1] in the United States, by type
(Thousand long tons)

Type	Agglomerates produced	
	1974	1975
Sinter, nodules, cinder	[2]37,762	[3]30,825
Pellets	59,719	62,779
Total	97,481	93,604

[1] Production at mines and consuming plants.
[2] Includes 18,715,000 tons of self-fluxing sinter.
[3] Includes 14,942,000 tons of self-fluxing sinter.

Table 15.—Stocks of usable iron ore at mines[1] Dec. 31, by district
(Thousand long tons)

District	1974	1975
Lake Superior	2,878	5,851
Southeastern States	636	612
Northeastern States	5,083	5,191
Western States	808	646
Total	9,405	[2]12,299

[1] Excluding byproduct ore.
[2] Data do not add to total shown because of independent rounding.

Table 16.—Average value of usable iron ore[1] shipped from mines or beneficiating plants in the United States in 1975
(Dollars per long ton)

Type of ore	District			
	Lake Superior	Southeastern	Northeastern	Western
Direct shipping, hematite and magnetite	10.81	--	--	8.77
Concentrates, hematite and magnetite	11.27	--	W	15.52
Concentrates, limonite	--	7.11	--	16.22
Agglomerates	23.57	--	W	25.57

W Withheld to avoid disclosing individual company confidential data.
[1] F.o.b. mine or plant. Excludes byproduct ore.

Table 17.—U.S. exports of iron ore, by country
(Thousand long tons and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Austria	--	--	--	--	5	132
Canada	2,266	32,869	1,814	30,061	2,485	59,170
France	(1)	1	27	329	6	78
Germany, West	17	126	(1)	(1)	--	--
Japan	457	4,819	439	4,691	39	658
Mexico	6	70	1	14	1	12
Sweden	--	--	40	20	--	--
Other	1	37	2	33	1	20
Total	2,747	37,922	2,323	35,148	2,537	[2]60,071

[1] Less than ½ unit.
[2] Data do not add to total shown because of independent rounding.

Table 18.—U.S. imports for consumption of iron ore, by country
(Thousand long tons and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Africa, Western, n.e.c	--	--	8	90	111	1,702
Angola	40	273	r 259	r 3,311	213	4,961
Argentina	31	340	--	--	--	--
Australia	464	5,840	638	7,292	803	8,512
Belgium-Luxembourg	17	160	--	--	(1)	(1)
Brazil	3,183	36,295	6,572	85,259	7,526	120,947
British West Africa	--	--	38	365	--	--
Canada	21,628	311,893	19,702	341,577	19,111	420,116
Chile	205	1,712	296	2,883	931	12,172
Gabon	--	--	57	577	--	--
Germany, West	(1)	(1)	r 16	590	--	--
India	--	--	--	--	164	1,661
Japan	--	--	--	--	56	1,024
Liberia	2,734	23,667	2,730	r 29,114	2,496	38,909
Mauritania	47	418	--	--	--	--
New Guinea	--	--	48	470	--	--
Norway	--	--	--	--	53	1,285
Peru	1,501	19,685	1,810	r 27,326	1,551	32,627
Philippines	25	633	15	392	13	478
South Africa, Republic of	--	--	1	21	128	2,475
Sweden	273	4,385	335	6,215	182	5,783
U.S.S.R	--	--	126	1,622	265	2,518
Venezuela	13,148	128,169	r 15,378	189,188	13,137	205,304
Other	(1)	18	(1)	7	(1)	22
Total [2]	43,296	533,488	48,029	696,298	46,743	860,496

r Revised.
[1] Less than ½ unit.
[2] Data may not add to totals shown because of independent rounding.

Table 19.—U.S. imports for consumption of iron ore, by customs district
(Thousand long tons and thousand dollars)

Customs district	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Baltimore	9,069	98,039	11,880	153,554	10,831	181,979
Buffalo	2,840	44,970	4,294	81,557	2,759	62,775
Charleston	13	141	70	790	154	4,076
Chicago	5,248	74,064	3,999	65,179	4,026	82,517
Cleveland	6,583	91,682	4,857	82,728	5,556	116,315
Detroit	1,465	20,544	1,428	28,034	1,899	45,556
Houston	1,005	15,517	925	16,844	690	14,938
Los Angeles	142	1,151	134	1,396	56	803
Mobile	4,107	43,669	5,776	73,414	4,265	70,764
New Orleans	524	6,469	677	8,762	624	10,344
Ogdensburg	4	431	4	392	1	79
Philadelphia	11,951	131,723	13,364	173,894	15,274	256,820
Portland, Oreg	157	1,925	270	3,074	310	5,407
San Juan	--	--	5	45	--	--
Wilmington, N.C	187	3,161	346	6,626	296	8,083
Other	1	2	(1)	9	1	39
Total [2]	43,296	533,488	48,029	696,298	46,743	860,496

[1] Less than ½ unit.
[2] Data may not add to totals shown because of independent rounding.

Table 20.—Iron ore, iron ore concentrates, and iron ore agglomerates: World production, by country

(Thousand long tons)

Country[1]	Gross weight[2]			Metal content[3]		
	1973	1974	1975[p]	1973	1974	1975[p]
North America:						
Canada[4]	[r] 49,420	49,187	46,128	[r] 30,512	30,344	28,724
Mexico[5]	[r] 4,596	4,928	4,820	3,064	3,286	3,213
Panama	[e] 80	--	--	[e] 50	--	--
United States[6]	87,669	84,355	78,866	53,478	51,457	48,266
South America:						
Argentina	234	148	[e] 300	104	65	[e] 130
Bolivia (exports)	[r] 16	--	31	[r] 10	--	20
Brazil	[r] 49,708	[r] 72,787	[e] 79,183	[e] 32,310	[e] 47,311	[e] 51,469
Chile	[r] 9,317	10,109	10,875	[r] 5,869	6,369	6,851
Colombia	[r] 432	437	529	[r] 186	188	227
Peru	8,823	9,375	7,630	[r] 5,760	6,124	4,987
Uruguay	4	--	--	[e] 2	--	--
Venezuela	22,745	26,007	24,381	[r] 13,397	15,604	14,629
Europe:						
Albania[7]	378	[e] 400	[e] 415	[e] 132	[e] 140	[e] 145
Austria	4,144	4,178	3,772	1,314	1,290	1,182
Belgium	114	121	92	34	36	28
Bulgaria	[r] 2,730	2,642	[e] 2,200	[r] 882	845	[e] 700
Czechoslovakia	1,646	1,661	1,745	494	498	523
Denmark	[r] 6	6	[e] 13	[r] [e] 2	[e] 2	[e] 5
Finland[8]	880	922	894	575	605	510
France	[r] 53,381	53,407	48,868	[r] 16,408	16,452	15,067
Germany, East[9]	51	25	[e] 60	13	6	[e] 15
Germany, West (salable)	4,989	4,369	3,236	[r] 1,594	1,390	1,036
Hungary	670	536	632	166	126	150
Italy[10]	502	584	532	221	257	234
Luxembourg	3,723	2,644	2,279	1,117	793	684
Norway	[r] 3,908	3,842	4,024	[r] 2,544	2,485	2,616
Poland	1,391	1,276	[e] 1,300	417	383	[e] 385
Portugal[11]	[r] 34	24	22	[r] 14	10	9
Romania	3,183	3,213	3,017	1,034	1,044	980
Spain	[r] 6,516	8,108	8,088	[r] 3,156	3,926	3,995
Sweden	34,179	35,582	30,380	[r] 21,722	22,495	19,331
U.S.S.R	212,691	221,446	229,320	125,488	130,653	135,299
United Kingdom	6,993	3,545	4,420	1,923	934	1,238
Yugoslavia	[r] 4,596	4,954	5,156	1,609	1,734	1,805
Africa:						
Algeria	[r] 3,086	3,732	3,149	1,666	2,016	1,701
Angola	5,957	5,413	5,512	[e] 3,600	[r] [e] 3,300	[e] 3,330
Egypt	646	1,281	1,103	323	641	551
Kenya	12	19	[12] 16	7	[e] 12	[e] 9
Liberia	23,170	23,409	[e] 22,637	14,134	14,280	[e] 13,808
Mauritania	10,314	11,482	8,549	5,542	7,233	5,514
Morocco	[r] 369	523	545	[r] 236	324	344
Rhodesia, Southern[e]	[r] 540	[r] 600	600	[r] 340	[r] 400	400
Sierra Leone	[r] 2,367	1,982	1,431	1,491	1,249	901
South Africa, Republic of[13]	10,782	11,370	12,104	6,739	7,107	7,565
Swaziland	[r] 2,111	2,044	2,186	[r] 1,330	1,288	1,377
Tunisia	796	805	639	423	424	352
Asia:						
China, People's Republic of[e]	55,000	59,000	64,000	[r] 27,600	29,500	32,000
Hong Kong	148	157	165	79	83	87
India	[r] 35,001	34,925	40,645	[r] 21,910	21,863	25,444
Indonesia	[r] 263	341	330	[r] 149	198	191
Iran[14]	837	984	984	510	600	600
Japan[15]	991	766	767	578	436	420
Korea, North[e]	8,800	9,300	9,300	3,500	3,700	3,700
Korea, Republic of	459	485	516	257	272	289
Malaysia	501	466	343	281	261	209
Philippines	2,219	1,583	1,330	1,276	910	799
Taiwan	24	[e] 25	[e] 25	12	[e] 12	[e] 12
Thailand	36	36	32	21	21	19
Turkey	[r] 2,530	2,221	1,878	[r] 1,406	1,235	1,044

See footnotes at end of table.

Table 20.—Iron ore, iron ore concentrates, and iron ore agglomerates: World production, by country—Continued

(Thousand long tons)

Country [1]	Gross weight [2]			Metal content [3]		
	1973	1974	1975 p	1973	1974	1975 p
Oceania:						
Australia	r 83,488	95,161	96,109	r 52,856	60,201	60,693
New Zealand [16]	2,147	2,316	2,261	1,224	1,320	1,289
Total	r 832,343	881,244	880,364	r 473,091	505,738	507,101

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Cuba and North Vietnam may produce iron ore, but definitive information on output, if any, is not available.

[2] Insofar as availability of sources permits, gross weight data in this table represent the nonduplicative sum of marketable iron ore, iron ore concentrates, and iron ore agglomerates produced by each of the listed countries. Moreover, concentrate and agglomerates produced from imported ores are excluded, under the assumption that the ore from which they are produced has been credited as marketable ore in the country where it was mined.

[3] Data represent actual reported weight of contained metal or are calculated from reported metal content. Estimated figures are based on latest available iron content reported except for the following countries, for which grades are U.S. Bureau of Mines estimates; Panama, Uruguay, Albania, Denmark, East Germany, Hungary, Southern Rhodesia, the People's Republic of China, and North Korea.

[4] Gross weight and metal content of shipments of usable iron ore, dry tons, including byproduct ore.

[5] Gross weight calculated from reported iron content based on grade of 66.67% iron.

[6] Includes byproduct ore.

[7] Nickeliferous iron ore.

[8] Includes magnetite concentrate, pelletized iron oxide (from pyrite sinter) and roasted pyrite (purple ore).

[9] Includes "roasted ore," presumably pyrite sinter, not separable from available sources.

[10] Excludes iron oxide pellets produced from pyrite sinter.

[11] Includes manganiferous iron ore.

[12] For cement manufacture.

[13] Includes byproduct magnetite as follows in thousand long tons: 1973—r 2,958; 1974—r 2,859; 1975—2,872.

[14] Year beginning March 21 of that stated.

[15] Concentrates including concentrate derived from iron sand as follows in thousand long tons: 1973—274; 1974—r 232; 1975—174.

[16] Largely concentrates from magnetite-titanium sands.

Table 21.—Major world trade in iron ores, concentrates, and agglomerates (excluding roasted pyrite)[1] in 1974

(Thousand long tons)

Source country	Recorded total 1974 exports of source country [3]	Recorded imports of principal recipient country [2]							
		Canada	United States	Belgium-Luxembourg	Czechoslovakia [4]	France	Germany, West	Hungary	Italy
Algeria	2,867	--	--	--	240	17	209	--	457
Angola	[5]5,516	--	259	--	(4)	448	1,314	--	--
Australia	[6]82,271	--	638	2,177	(4)	1,588	4,705	--	2,199
Brazil	58,500	528	6,572	1,617	467	4,025	11,791	7	3,215
Canada	36,857	XX	19,702	--	(4)	645	3,913	--	1,966
Chile	9,242	--	296	--	(4)	--	--	--	--
France	19,520	--	--	13,320	(4)	XX	3,617	--	--
India	21,900	--	--	--	614	--	554	99	--
Liberia	25,188	--	2,730	1,933	(4)	2,044	9,591	--	3,751
Malaysia	155	--	--	--	(4)	--	--	--	--
Mauritania	[6]10,138	--	--	1,295	(4)	2,413	1,492	--	1,179
Norway [7]	2,766	--	--	--	(4)	54	1,439	--	--
Peru	e 6,700	--	1,810	--	(4)	348	1,149	--	102
Philippines	1,103	--	15	--	(4)	--	--	--	--
Sierra Leone	[5]1,431	--	--	--	(4)	--	699	--	--
South Africa, Republic of	e 2,848	31	1	--	(4)	20	468	--	242
Spain	2,915	--	--	--	(4)	471	1,039	--	--
Swaziland	[6]2,442	--	--	--	(4)	--	182	--	--
Sweden [7]	32,582	101	335	8,735	538	2,622	10,419	--	--
U.S.S.R	42,616	--	126	--	11,638	32	1,023	3,909	1,649
United States	2,323	1,637	XX	--	(4)	--	44	--	--
Venezuela	[6]25,442	--	15,378	--	(4)	589	2,668	--	1,807
Other countries	[8]3,950	--	121	--	(4)	120	494	--	271
Origin unreported	XX	--	47	3,824	267	136	--	25	932
Total	399,272	2,297	48,030	32,901	13,764	15,572	56,810	4,040	17,770

Source country	Recorded imports of principal recipient country [2]								
	Netherlands	Poland [4]	Romania [4]	United Kingdom [4]	Other Europe [9]	Japan	Other Asia and Pacific [10]	Other Western Hemisphere [11]	Total of listed imports
Algeria	--	(4)	(4)	(4)	82	--	--	--	1,005
Angola	--	(4)	(4)	121	95	2,755	--	--	4,992
Australia	--	(4)	(4)	779	1,709	66,809	756	(12)	81,360
Brazil	1,588	[13]625	[13]815	3,091	3,099	19,215	--	--	56,656
Canada	591	(4)	(4)	4,224	620	4,433	20	--	36,114
Chile	--	(4)	(4)	(4)	--	8,436	--	--	8,732
France	(12)	(4)	(4)	(4)	(12)	--	--	--	16,937
India	--	[13]333	[13]1,322	(4)	--	17,095	528	--	20,545
Liberia	1,570	(4)	(4)	690	847	1,294	--	--	24,450
Malaysia	--	(4)	(4)	(4)	--	83	29	--	112
Mauritania	300	(4)	(4)	1,509	697	2,152	--	--	11,037
Norway	--	(4)	(4)	1,057	277	65	--	--	2,892

See footnotes at end of table.

Peru	--	(4)	(4)	(4)	--	5,866	172	13	9,460
Philippines	--	(4)	(4)	(4)	--	1,610	8	--	1,633
Sierra Leone	313	(4)	(4)	(4)	--	1,002	--	--	2,014
South Africa, Republic of	--	(4)	(4)	57	3	2,276	(12)	--	3,098
Spain	297	(4)	(4)	223	35	--	--	--	2,065
Swaziland	--	(4)	(4)	(4)	--	1,895	--	--	2,077
Sweden	1,826	[13] 2,423	(4)	3,863	1,659	--	--	--	32,521
U.S.S.R	--	[13] 11,209	[13] 5,609	1,074	5,299	971	--	--	42,539
United States	--	(4)	(4)	(4)	22	337	(12)	(12)	2,040
Venezuela	194	(4)	(4)	1,701	882	--	--	--	23,219
Other countries	272	(4)	(4)	(4)	17	3,416	39	24	[14] 4,874
Origin unreported	--	772	2,098	974	1,594	--	1	1,181	11,851
Total	6,951	[15] 15,363	9,844	19,363	17,037	139,710	1,553	1,218	402,223

XX Not applicable.

[1] Disparities between recorded total exports of source countries and totals of recorded imports of recipient countries from each listed source country are generally due to (1) time lag between shipment and receipt, and (2) the fact that the latter totals are incomplete, representing only the imports of the nations listed in the column heads and in footnotes 9, 10, and 11.

[2] Unless otherwise specified, data are compiled from official import statistics of listed recipient countries.

[3] Unless otherwise specified, data are from official export statistics of listed source countries.

[4] Official import statistics for Czechoslovakia, Poland, Romania, and the United Kingdom do not fully distribute total imports by country of origin, and therefore do not clearly indicate whether these nations received shipments from any of the source countries where this footnote has been entered.

[5] Exports not available. Production reported in lieu of exports as all or nearly all output is exported.

[6] Official mineral statistics publication of source country rather than official trade returns.

[7] In previous editions of this table, import figures for various recipient countries were adjusted to account for Swedish ores shipped through Narvik, Norway, and erroneously credited to Norway by such recipient countries. No such adjustment is necessary for 1974.

[8] Summation of (1) recorded exports of the following countries, with export quantity following country name in thousand long tons: Austria—1; Belgium-Luxembourg—68; Denmark—6; West Germany—5; Hong Kong—157; Italy—18; the Republic of Korea—75; Morocco—10; the Netherlands—193; New Zealand—2,200; Tunisia—518; together with (2) apparent exports (as measured by imports of trading partner countries) with apparent export quantity following country name in thousand long tons, and trading partner countries listed in parentheses: Indonesia—366 (Japanese imports only); North Korea—300 (Japanese imports only); Panama—23 (Mexican imports only); Poland—10 (West German imports only). In addition to the foregoing list of countries, Mexico, Monaco, Switzerland, the United Kingdom, and Yugoslavia recorded iron ore exports, but each of these nations individually exported less than 500 tons.

[9] Includes the following countries with recorded total imports of each following the country name in thousand long tons: Austria—2,756; Bulgaria—2,358; Denmark—less than ½ unit; Finland—1,115; East Germany—2,763; Greece—1,009; Norway—1,287; Portugal—10; Spain—5,197; Sweden—80; Switzerland—38; Yugoslavia—424.

[10] Includes the following countries with recorded total imports of each following the country name in thousand long tons: Australia—28; the Republic of Korea—1,373; Malaysia—less than ½ unit; Singapore—10; Taiwan—142.

[11] Includes the following countries with recorded total imports of each following the country name in thousand long tons: Argentina—1,181; Brazil—less than ½ unit; Mexico—37; Venezuela—less than ½ unit.

[12] Less than 500 long tons.

[13] Official export statistics of source country.

[14] Includes the following reported source countries with total quantity credited to each following the country name in thousand long tons: Belgium-Luxembourg—46; Czechoslovakia—73; Denmark—4; Finland—8; Gabon—57; West Germany—16; Greenland—10; Hong Kong—177; Indonesia—366; Iran—1; Italy—14; Japan—39; New Guinea—48; North Korea—300; the Republic of Korea—82; Morocco—356; Mozambique—139; the Netherlands—2; New Zealand—2,371; Nigeria—2; Panama—295; the People's Republic of China—less than ½ unit; Poland—1; Portugal—332; Thailand—23; Tunisia—112; the United Kingdom—less than ½ unit.

[15] Quarterly Bulletin of Steel Statistics for Europe, No. 1, 1975.

Table 22.—World trade in iron ore, iron ore concentrates, and iron ore agglomerates, 1975 (preliminary)

(Thousand long tons)

Exporting country	Exports [1]	Imports, as reported by recipient countries: Japan	United States	West Germany	Belgium-Luxembourg	United Kingdom	Italy	France	Netherlands	Spain	Austria	Canada	Poland	Czechoslovakia	Romania	Hungary	Other [2]
Angola	e 2,600	1,408	213	592	--	--	--	395	--	50	--	--	--	--	--	--	95
Australia	79,088	62,254	803	6,311	2,234	844	2,051	1,649	677	893	--	--	--	--	--	--	e 3,200
Brazil	71,376	23,089	7,526	10,489	1,913	2,170	3,045	3,435	1,741	1,569	1,450	679	--	649	--	4	e 3,500
Canada	35,465	3,838	19,111	4,001	[1] 110	3,013	1,961	521	915	731	99	--	--	--	--	--	--
Chile	9,253	7,929	931	56	--	--	--	--	--	--	--	--	--	--	--	--	--
France	15,738	--	--	2,582	10,631	--	--	--	--	4	--	--	--	--	--	--	--
India	e 22,800	16,525	164	966	58	--	--	--	138	--	--	--	[1] 670	469	e 2,300	205	--
Liberia	18,110	520	2,496	6,098	902	497	2,785	1,880	1,065	607	225	--	--	488	--	--	--
Mauritania	8,494	960	--	594	906	1,584	--	2,121	365	595	--	--	--	--	--	--	--
New Zealand	2,268	2,464	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Norway	3,104	--	53	1,142	--	1,613	--	--	--	--	--	32	--	--	--	--	--
Peru	e 5,500	2,689	1,551	583	--	208	--	437	--	--	--	--	--	--	--	--	--
Philippines	1,488	1,489	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sierra Leone	1,205	892	--	605	--	--	--	--	--	--	--	--	--	--	--	--	--
Spain	1,929	--	--	865	--	148	--	306	385	--	--	--	--	--	--	--	--
South Africa, Republic of	3,284	1,607	128	292	--	67	--	--	--	132	--	--	--	--	--	--	--
Swaziland	1,878	1,698	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sweden	22,716	--	182	5,671	4,841	2,207	--	1,620	1,513	455	--	126	--	412	--	--	--
United States	2,537	--	--	--	--	--	--	--	--	50	--	3,915	--	--	--	--	--
U.S.S.R	42,937	1,224	265	167	--	954	1,659	25	--	--	705	--	[1] 10,936	12,029	[1] 6,189	3,985	e 4,400
Venezuela	21,138	--	13,137	1,844	--	1,775	2,126	417	319	927	--	--	--	--	--	--	--
Other [3]	e 2,000	991	170	764	3,523	453	1,775	62	114	25	58	14	3,572	521	2,218	--	2,332
Total	[4] 374,908	129,577	46,743	43,622	25,118	15,533	15,402	12,868	7,232	6,038	2,537	4,766	15,178	14,568	10,707	4,194	e 13,527

e Estimate.
[1] As reported by exporting country or by producers in exporting country.
[2] Including Argentina, Bulgaria, East Germany, Finland, Greece, Norway, the People's Republic of China, Portugal, the Republic of Korea, Sweden, Turkey, and Yugoslavia. Based partly on destinations as reported by exporting countries.
[3] Including Algeria, Hong Kong, Indonesia, Malaysia, Morocco, Mozambique, the Netherlands, North Korea, the Republic of Korea, Thailand, and Tunisia. Based largely on sources reported by importing countries.
[4] Imports reported by recipient countries total approximately 368 million tons.

Iron Oxide Pigments

By Cynthia T. Collins [1]

Production and trade in iron oxide pigments fell sharply in 1975. Following the trend in the automobile and construction markets, demand for pigments in the coatings, plastics, and other industries was greatly reduced. Sales of finished iron oxide pigments, valued at $46 million, and imports, valued at $9 million, indicated a $55 million domestic market in 1975. This was in contrast to a $77 million market in 1974. Plant expansions contributed to an adequate supply at the beginning of the year, although continued production and falling demand resulted in large inventories. Plants operated below capacity for most of the year. However, when overall economic improvement in related industries occurred, demand for pigments increased. Production accelerated toward yearend but was not sufficient to offset the earlier downward trend.

The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., published a fourth edition of *Industrial Minerals and Rocks* in 1975. The chapter, "Mineral Pigments," by Kenneth R. Hancock, gives comprehensive coverage of iron oxide pigments, including natural and synthetic pigments, their chemical and physical properties, sources, manufacturing processes, end uses, and marketing.[2]

Table 1.—Salient iron oxide pigments statistics in the United States

		1971	1972	1973	1974	1975
Mine production	short tons	W	W	W	W	38,073
Crude pigments sold or used	do	W	W	W	W	34,825
Value	thousands	$415	$418	$931	$1,429	$1,093
Iron oxides from steel plant wastes	short tons	NA	NA	NA	W	19,252
Value	thousands	NA	NA	NA	W	$1,102
Finished pigments sold	short tons	128,300	152,412	148,802	r 147,544	104,840
Value	thousands	$31,000	$37,673	$43,514	r $60,612	$46,206
Exports	short tons	r 3,984	r 4,268	r 9,888	r 9,666	8,780
Value	thousands	r $1,680	r $1,926	r $3,101	r $3,466	$2,523
Imports for consumption	short tons	r 36,496	r 47,271	r 51,183	r 54,215	27,979
Value	thousands	r $6,155	r $8,529	r $12,005	r $16,367	$9,184

r Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data.

DOMESTIC PRODUCTION

Production of finished iron oxide pigments in 1975, as measured by sales, declined 29% from that of 1974. The decline was greater for synthetic than for natural pigments. The corresponding 24% decrease in value of total shipments reflected higher unit values for synthetic pigments. Average value of synthetic pigments rose 17% from $0.303 per pound in 1974 to $0.355 in 1975, and was more than 4 times the average unit value of natural oxides.

Response to the Bureau of Mines canvass for data on finished iron oxide pig-

[1] Mineral specialist, Division of Ferrous Metals.

[2] Hancock. K.R. Mineral Pigments ch. in Industrial Minerals and Rocks. ed. by Stanley J. Lefond. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, 4th ed., 1975, pp. 335–357.

ments increased in 1975. Twenty-one companies reported shipments from 27 plants in 13 States. Pfizer Inc. and Reichard-Coulston, Inc. were the largest producers of both synthetic and natural oxides. Cities Service Co., Columbian Div., was also a leading synthetics producer, while the Prince Manufacturing Co., Delta Color & Supply Co., and Blue Ridge Talc Co., Inc., were significant producers of finished natural pigments. Ten producers accounted for 95% of the 1975 sales of all finished pigments.

Production of crude iron oxide pigments also declined in 1975. Shipments and values were less than they were in 1974, but the 1975 average unit value of $0.016 was a 23% increase over that of 1974. Crude reds, yellows, blacks, and browns were produced variously by the four companies listed in table 3. Hoover Color Corp. and New Riverside Ochre Co. produced both crude and finished pigments.

Four steel companies reported production of 19,252 tons of iron oxides as a byproduct from steel plant dusts or regenerated pickle liquor. These products were reported for the first time in 1975 and were sold principally for use in ferrite manufacture.

Table 2.—Finished iron oxide pigments sold by processors in the United States, by kind

Pigment	1974 r		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Natural:				
Brown:				
Iron oxide (metallic) [1]	13,016	$2,945	10,545	$2,087
Umbers:				
Burnt	5,754	1,933	3,964	1,506
Raw	1,937	602	1,454	542
Red:				
Iron oxide [2]	34,957	2,829	28,486	2,384
Sienna, burnt	964	475	632	338
Yellow:				
Ocher [3]	7,094	670	4,209	472
Sienna, raw	1,055	379	638	305
Total natural	64,777	9,833	49,928	7,634
Synthetic:				
Brown: Iron oxide [4]	9,121	6,003	5,730	4,494
Red: Iron oxide	33,653	19,888	20,596	13,927
Yellow: Iron oxide	31,526	19,049	19,303	13,998
Total synthetic	74,300	44,940	45,629	32,419
Unspecified, including mixtures of natural and synthetic iron oxides	8,467	5,839	9,283	6,153
Grand total	147,544	60,612	104,840	46,206

r Revised.
[1] Includes black magnetite and Vandyke brown.
[2] Includes pyrite cinder.
[3] Includes yellow iron oxide.
[4] Includes black magnetite.

Table 3.—Producers of iron oxide pigments in the United States in 1975

Producer	Mailing address	Plant location
Finished pigments:		
Blue Ridge Talc Co., Inc	P.O. Box 39 Henry, Va. 24102	Henry, Va.
Chemalloy Co., Inc	County Line Rd. No. 950 Bryn Mawr, Pa. 19101	Bryn Mawr, Pa.
Chemetron Pigments	491 Columbia Ave. Holland, Mich. 49423	Huntington, W. Va.
Cities Service Co., Columbian Div.	P.O. Box 5373 Akron, Ohio 44313	St. Louis, Mo., Monmouth Junction, N.J., Trenton, N.J.
Combustion Engineering, CE Minerals Div.	901 East 8th Ave. King of Prussia, Pa. 19406	Camden, N.J.
Delta Color & Supply Co	1050 East Bay St. Milwaukee, Wisc. 53207	Milwaukee, Wisc.
E. I. Du Pont de Nemours & Co.	Pigments Dept. Wilmington, Dela. 19898	Newark, N.J.
Ferro Corp., Ottawa Chemical Div.	700 North Wheeling St. Toledo, Ohio 43605	Toledo, Ohio.
Foote Mineral Company	Route 100 Exton, Pa. 19341	Exton, Pa.
Greenback Industries, Inc., Greenback Ferrite Div.	Route 2, Box 63 Greenback, Tenn. 37742	Greenback, Tenn.
Hercules Incorporated, C&SP Dept.	720 Commerce St. Pulaski, Va. 24301	Pulaski, Va.
Hoover Color Corp	P.O. Box 218 Hiwassee, Va. 24347	Hiwassee, Va.
Indiana General Corp	405 Elm St. Valparaiso, Ind. 46383	Valparaiso, Ind.
Mineral Pigments Corp	7011 Muirkirk Rd. Beltsville, Md. 20705	Beltsville, Md.
New Riverside Ochre Co	Box 387 Cartersville, Ga. 30120	Cartersville, Ga.
Pfizer Inc., Mineral Pigments Div.	235 East 42d St. New York, N.Y. 10017	Emeryville, Calif., East St. Louis, Ill., Easton, Pa. Quincy, Ill.,
Prince Manufacturing Co	700 Lehigh St. Bowmanstown, Pa. 18030	Bowmanstown, Pa.
Reichard-Coulston, Inc	15 East 26th St. New York, N.Y. 10010	Bethlehem, Pa.
George B. Smith Chemical Works, Inc.	1 Center St. Maple Park, Ill. 60151	Maple Park, Ill.
Solomon Grinding Service	P.O. Box 1766 Springfield, Ill. 62705	Springfield, Ill.
Sterling Drug Inc., Hilton-Davis Chemicals Div.	2235 Langdon Farm Rd. Cincinnati, Ohio 45237	Cincinnati, Ohio.
Sterling Drug Inc., Thomassett Color Div.	120 Lister Ave. Newark, N.J. 07105	Newark, N.J.
Crude pigments:		
The Cleveland-Cliffs Iron Co	1460 Union Commerce Bldg. Cleveland, Ohio 44115	Ishpeming Mich.
Hoover Color Corp	P.O. Box 218 Hiwassee, Va. 24347	Hiwassee, Va.
Bethlehem Steel Corp., Meramec Mining Co.	Martin Towers Bethlehem, Pa. 18016	Sullivan, Mo.
New Riverside Ochre Co	Box 387 Cartersville, Ga. 30120	Cartersville, Ga.

CONSUMPTION AND USES

Apparent domestic consumption[3] of 124,039 tons of iron oxide pigments in 1975 was a 35% decline from the 1974 level of 192,093 tons. Demand for pigments in industrial coatings, plastics, and other markets affected by the automotive and construction industries was greatly reduced during most of the year, while demand for pigments in trade sales (paints, stains, varnishes, etc.), was relatively constant throughout the year. Consumption was off in all pigments categories, except natural black magnetite, sales of which increased over 1974 levels. Reds comprised 47% of all finished-pigment sales in 1975, while yellows accounted for 23%.

Data are not collected by the Bureau of Mines on specific uses for iron oxide pigments; figures in table 2 do not necessarily reflect all sales of iron oxides used for pigments and other nonsmelting purposes. A major use of iron oxide pigments is in protective coatings for industrial and marine uses. In coating strip metal the pigments contribute protective and decorative properties to ships, automobiles, and durable goods. Natural pigments are used extensively in primers, surfacers, and top coat paints for exterior protection on barns, houses, roofs, floors, cement, and freight cars. Some interior uses are for wood stains, antiquing kits, wallpaper designs, and plastics. In the construction industry, the pigments are used to color concrete blocks and other decorative products. Synthetic oxides find uses in paints, plastics, rubber, leather, fibers, and wood-grain films. Synthetics are used also in the manufacture of ferrites for magnetic tape and ink, magnetic door latches, and various electronic devices. Because of their nontoxic nature, iron oxide pigments are also used in cosmetics, as food additives, and in paper products for food packaging. Some miscellaneous uses are for jeweler's rouge, foundry sands, and soil conditioners.

PRICES

Iron oxide pigment prices remained relatively stable throughout 1975, after large increases in 1974. Slight increases occurred in only two categories; red domestic primers increased by 3 cents per pound in April, and yellow other shades rose 10 cents per pound in November.

[3] Indicated by quantity of finished iron oxide pigments sold plus imports of natural and synthetic iron oxide pigments minus exports of pigment-grade iron oxides and hydroxides.

Table 4.—Prices quoted on finished iron oxide pigments, per pound, bulk shipments, as of December 31, 1975

Pigment	Low	High	Pigment	Low	High
Black:			Red:		
Synthetic	$0.3100	$0.3200	Domestic primers	--	$0.1800
Micaceous	.3800	.4000	Pure, synthetic	$0.3475	.3725
Brown:			Domestic, pure	.2000	.2300
Ground iron ore	.0750	.0900	Yellow:		
Metallic	.1175	.1275	Synthetic	.3350	.3650
Pure, synthetic	.3525	.4000	Ocher, domestic	.0650	--
Sienna, Italian, burnt	.3250	.3700	Natural, French type	.1800	--
Sienna, American, burnt	.2600	.3700	Other shades	.3450	.3650
Sienna, American, raw	.1800	.2800			
Umber, American, burnt	--	.1925			
Umber, American, raw	.1800	.2200			
Umber, Turkey, burnt	.1925	.2300			
Umber, Turkey, raw	.1800	.2300			
Vandyke, imported	--	.2250			

Sources: American Paint Journal and Chemical Marketing Reporter.

FOREIGN TRADE

The quantity of pigment-grade iron oxides and hydroxides exported from the United States in 1975 decreased 9% to 8,780 tons, compared with exports of 9,666 tons in 1974. A corresponding decline in the value of exports reflected a 20% decrease in the average unit value of $0.144 per pound. Canada received 85% of total U.S. exports, compared with 79% in 1974.

Imports for consumption of 27,979 tons of iron oxide pigments were 48% below the 54,215 tons imported in 1974. The decrease was due to overall lower demand and the recovery by domestic industry of that portion of the market which had relied on low-grade iron oxides from Japan and some European countries during the previous 2 years. Corresponding values of imports declined 44% in 1975. Average unit values for natural and synthetic pigments increased 7% and 8% to $0.061 and $0.193, respectively.

Siennas and umbers from Cyprus comprised 68% of natural iron oxide imports, while oxides from Spain accounted for 11%. West Germany accounted for 54% of the quantity and 68% of the value of synthetic imports; Canada contributed 35% and 19%. Imports from traditional sources declined in 1975, but small quantites from the People's Republic of China and Mexico showed an increase.

Table 5.—U.S. exports of iron oxide and hydroxides, by country

Destination	1974				1975			
	Pigment grade		Other grade		Pigment grade		Other grade	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	242	$269	57	$83	130	$82	1	$3
Bahamas	12	5	36	54	--	--	--	--
Belgium-Luxembourg	70	40	147	92	20	17	14	12
Brazil	52	47	178	145	46	56	99	97
Canada	7,590	1,422	1,526	1,098	7,484	1,494	797	445
Colombia	32	18	93	90	15	10	5	2
Ecuador	17	5	2	1	3	4	2	1
France	184	174	148	98	103	106	179	171
Germany, West	192	427	101	57	143	81	241	480
India	23	8	23	35	--	--	32	8
Indonesia	--	--	--	--	--	--	59	26
Iran	46	15	1	6	--	--	159	269
Italy	69	50	696	744	5	8	453	498
Japan	129	98	1,358	1,718	6	20	848	1,155
Korea, Republic of	(1)	1	3	2	24	11	4	6
Mexico	142	94	80	73	96	50	139	148
Netherlands	33	37	478	593	49	32	525	708
New Zealand	22	21	7	16	2	1	--	--
Panama	10	5	7	4	3	3	36	5
Peru	11	8	5	6	30	10	7	10
Philippines	17	15	24	18	66	53	3	4
Portugal	4	3	28	30	--	--	23	25
South Africa, Republic of	10	9	16	21	3	20	39	57
Spain	30	16	37	20	--	--	40	20
United Kingdom	334	281	682	806	321	303	507	746
Venezuela	167	159	58	41	136	88	145	155
Vietnam, South	23	18	--	--	--	--	--	--
Other	205	221	128	120	95	74	94	136
Total	9,666	3,466	5,919	5,971	8,780	2,523	4,451	5,187

[1] Less than ½ unit.

Table 6.—U.S. imports for consumption of selected iron oxide pigments

Kind	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Natural:				
Crude:				
Ochers	13	$5	--	--
Siennas	1,198	243	452	$91
Umbers	6,748	365	3,894	282
Other	230	67	128	60
Total	8,189	680	4,474	433
Refined:				
Ochers	40	5	20	3
Siennas	111	21	69	16
Umbers	1,042	200	357	68
Vandyke brown	958	183	319	57
Other	1,932	309	873	163
Total	4,083	718	1,638	307
Synthetic	41,943	14,969	21,867	8,444
Grand total	54,215	16,367	27,979	9,184

Table 7.—U.S. imports for consumption of iron oxide and iron hydroxide pigments, by country

Country	Natural				Synthetic			
	1974		1975		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Austria	--	--	40	$19	--	--	--	--
Belgium-Luxembourg	3	$11	83	34	30	$7	--	--
Brazil	--	--	--	--	--	--	1	(1)
Canada	128	32	11	4	11,706	2,685	7,625	$1,611
China, People's Republic of	--	--	11	1	--	--	4	3
Cyprus	7,763	502	4,134	309	--	--	--	--
France	--	--	3	2	38	15	--	--
Germany, West	986	213	260	59	22,312	9,412	11,858	5,712
Hong Kong	--	--	--	--	52	22	--	--
India	110	12	90	10	55	6	--	--
Italy	870	211	398	94	--	--	--	--
Japan	128	46	71	32	4,697	1,804	942	596
Korea, Republic of	29	15	55	24	114	56	--	--
Mexico	3	(1)	--	--	493	170	606	210
Netherlands	53	15	--	--	20	10	--	--
South Africa, Republic of	20	4	20	3	--	--	--	--
Spain	1,694	215	684	94	216	65	51	10
Sweden	5	2	--	--	--	--	--	--
United Kingdom	480	120	252	55	2,210	717	780	302
Total	12,272	1,398	6,112	740	41,943	14,969	21,867	8,444

[1] Less than ½ unit.

TECHNOLOGY

Increasing concern about the environment and pollution control regulations have led to development of techniques for regeneration of steel plant wastes. Several processes developed for the recycling of hydrochloric acid from ferrous chloride leach liquors also recover iron oxide as a byproduct or coproduct. A developing market for these oxides has led to modifications of systems in order to produce oxides specifically for the pigment and electronics industries. The Pori, Woodall-Duckham, and Keramchemie/Lurgi processes, the Falconbridge fluid-bed hydrolyzer process and the Steel Co. of Canada, Ltd.'s spray roasting procedures were described in the January and February 1975 issues of Canadian Mining and Metallurgical Bulletin.[4] A U.S. patent describes the development of an improved gamma iron oxide for magnetic recording, from a starting base of ferrous chloride. An aqueous alkali is combined with the ferrous chloride to precipitate colloidal seed hydrous iron oxide; seed is grown under controlled conditions to an amount up to double the seed weight. The synthetic oxide, lepidocrocite, is then reduced to magnetite and oxidized to magnetic gamma ferric oxide.[5]

Increasing importance is being placed on the protection of certain objects and products against deterioration by high-energy ultraviolet (UV) radiation. Iron oxide pigments are used in all bonding systems in which long-term protection, together with light transparency, is required. Studies have been made on the use of transparent iron oxides as UV absorbers. One study found that, by comparative investigation of three tint-separable pigments in the UV and visible range, it was possible to select the most favorable pigment for a specific type of application. Those pigments studied were yellow 088 VN, orange 188 VN, and red 288 VN.[6] Because the optical and technologic properties of transparent iron oxides depend upon dispersion of the pigment in the vehicle, research was carried out on dispersion and dispersion apparatus. Some of those tested were the conventional ball mill, attrition mill, continuous agitation mill, and calender. Transparent oxides usually require prewetting; therefore, various methods and wetting agents were also tested. The most effective was found to be predispersion in the dissolver of ground iron oxide and 45% solid alkyd solution in 1:1 weight ratio; 5% to 10% butanol was used as the wetting agent, with predispersion lasting for 1 to 2 hours. It was concluded that there is no one best dispersion apparatus because each requires its own definite material formulation.[7] A process was patented for producing a heat-stable transparent yellow oxide pigment. Iron carbonyl was burnt and the combustion products rapidly chilled to give a noncrystalline amorphous pigment containing a small amount of carbon.[8]

Micaceous iron oxide (MIO) is noted for its long-lasting corrosion protection properties in paints. Industrial manufacturing techniques for synthetic MIO were developed in Japan. It was found that copperas from TiO_2 plants can be used as a raw material and byproduct sodium hydroxide, generated in the manufacturing process, can be recycled.[9] Synthetic MIO having very smooth surfaces was coated with an oxide having a high refractive index, such as TiO_2. This gave improved properties over those of synthetic MIO alone, and allowed variations of color—gold, violet, blue, and green—to be obtained as interference colors. Coating was accomplished through hydrolysis of a titanium salt solution.[10] Nacreous pigments as a satisfactory substitute for gold bronzes were made by three steps: (1) Precipitation of TiO_2 or ZrO_2 on mica flakes; (2) precipitation of ferrous hydroxide onto the coated mica flakes; and (3) oxidation of the deposit to convert the iron hydroxide to hematite. The hydroxide was precipitated from a ferrous salt solution.[11] By this

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[4] Burtch, J. W. Hydrochloric Acid From Industrial Waste Streams—The PORI Process. Can. Min. and Met. Bull., v. 68, No. 753, January 1975, pp. 96–100.

Conners, A. Hydrochloric Acid Regeneration as Applied to the Steel and Mineral Processing Industries. Can. Min. and Met. Bull., v. 68, No. 754, February 1975, pp. 1–7.

Rupay, G. H., and C. J. Jewell. The Regeneration of Hydrochloric Acid From Waste Pickle Liquor Using the Keramchemie/Lurgi Fluidized-Bed Reactor System. Can. Min. and Met. Bull., v. 68, No. 754, February 1975, pp. 89–93.

Schuldt, A. A. Regeneration of Hydrochloric Acid Pickle Liquor at Stelco's Hilton Works. Can. Min. and Met. Bull., v. 68, No. 754, February 1975, pp. 82–88.

Van Weert, G., E. C. Robertson, and J. H. Christiansen. Treatment of Ferrous Chloride Liquors in the Falconbridge Fluid-Bed Hydrolizer. Can. Min. and Met. Bull., v. 68, No. 753, January 1975, pp. 87–95.

[5] Bennetch, L. M., H. S. Greiner, K. R. Hancock, and M. Hoffman (assigned to Pfizer Inc., New York, N.Y.). Magnetic Impulse Record Member. U.S. Pat. 3,904,540, Sept. 9, 1975.

[6] Finus, F. Application of Transparent Iron Oxide as an UV-Absorber. Farbe und Lack, v. 81, No. 7, 1975, pp. 604–607.

[7] Kelch, W. Dispersion of Transparent Iron Oxide. Deutsche Farben-Zeitschrift, v. 29, No. 3, March 1975, pp. 118–123.

[8] Ebenhoech, F. L., D. Werner, G. Bock, G. Wunsch, K. Opp, and W. Ostertag (assigned to BASF Aktiengesellschaft, Ludwigshafen, West Germany). Transparent Yellow Iron Oxide Pigment. U.S. Pat. 3,918,985, Nov. 11, 1975.

[9] Takahashi, Mitsunao. Manufacture and Characteristics of Synthetic Micaceous Iron Oxide (MIO). Chem. Econ. & Eng. Rev., v. 7, No. 5, May 1975, pp. 28–31, 43, see also U.S. Pat. 3,869,298.

[10] Suzuki, M., M. Tachibana, and T. Moriari (assigned to Teikoku Kako Co., Ltd., Japan). Iron Oxide Pigments and Process for the Production Thereof. U.S. Pat. 3,869,298 Mar. 4, 1975.

[11] Bernhard, H., and R. Esselborn (assigned to Merck Patent Gesellschaft m.b.H., West Germany). Nacreous Pigments and Process for the Production Thereof. U.S. Pat. 3,874,890, Apr. 1, 1975.

method a range of interference colors may be produced.[12]

The iron oxides have a number of specialty nonpigment uses. Experiments were carried out using polymer particles containing iron oxides for use as filter aids. It was found that magnetization improved the performance of the filter aids and that the particles can be successfully cleaned and returned to the filter for reuse.[13] A method was developed to improve the mechanical properties of synthetic resins by incorporating fume particles from steelmaking into the resin. The particles were less than 20 micrometers in diameter and were alined magnetically during setting of the resin.[14] In Japan Santetsu Kogyo K. K. developed a low-cost emission antipollution catalyst made from reclaimed iron oxide. The catalyst reportedly removed 91% of the nitrogen oxide from automobile exhausts at 400° C and 96% at 450° C.[15] TDK Electronics Co. Ltd. made a low-cost catalyst of active alumina coated with ferrite. Tests were reported to show that nitrogen oxide content of auto emissions could be reduced to 0.17 grams per kilometer with use of this catalyst.[16]

The growing market for ferrites generated research into various aspects of their production. Comparative studies were made on the sintering behavior of ferrite powders produced by several methods. Ferrites produced by conventional calcining and ball mill grinding were compared with those produced by dry methods and those based on coprecipitation. Best results were obtained by freeze-and-spray drying; the product was more homogeneous and was sintered at lower temperatures or by hot-pressing.[17] Dense, spherical ferrite particles, suitable for use as the carrier in electrostatographic copiers, were prepared by making a slurry of powder mixes having the desired nickel-zinc or manganese-zinc ferrite composition. The slurry was spray-dried to give beads about 100 micrometers in diameter, which were sintered to avoid agglomeration. A deflocculent was the only additive necessary in this process.[18] In a similar procedure, the incorporation of lithium cations at 600° C prevented volatilization during sintering, and the product proved to be a significant improvement over conventionally prepared material.[19] An annotated literature survey covering major developments in the area of microwave ferrite materials and devices was published in 1975. The bibliography covers the period 1968–74.[20]

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[12] Bernhard, H., R. Esselborn, R. Hesse, and H. Russman (assigned to Merck Patent Gesellschaft m.b.H., West Germany). Iron-Containing Mica Flake Pigments. U.S. Pat. 3,926,659, Dec. 16, 1975.

[13] Bolto, B. A., K. W. V. Cross, R. J. Eldridge, E. A. Swinton, and D. E. Weiss. Magnetic Filter Aids. Chem. Eng. Prog., v. 71, No. 12, December 1975, pp. 47–50.

[14] Rohatgi, P.K. (assigned to Bethlehem Steel Corp.). Method of Making Synthetic Resin Composites With Magnetic Fillers. U.S. Pat. 3,867,299, Feb. 18, 1975.

[15] American Metal Market. Exhaust Catalyst Is Developed by Santetsu. V. 82, No. 148, July 31, 1975, p. 5.

[16] Mining Journal. Japanese Low-Cost Catalyst? V. 284, No. 7295, June 13, 1975, p. 466.

[17] De Lau, J. G. M., P. F. G. Bongaerts, J. L. H. M. Wijgergangs, and A. L. Stuijts. Investigation of Chemical Inhomogeneities in Ferrite Hot Pressing Powders. Ber. Dt. Keram. Ges., v. 52, No. 7, July 1975, pp. 207–210

[18] Berg, A. C., R. Fargensi, and A. F. Lipani (assigned to Xerox Corp., Stamford, Conn.). Electrostatographic Developer Mixtures Comprising Ferrite Carrier Beads. U.S. Pat. 3,914,181, Oct. 21, 1975.

Jones, L.O. (assigned to Xerox Corp., Stamford, Conn.). Stoichiometric Ferrite Carriers. U.S. Pat. 3,929,657, Dec. 30, 1975.

[19] Miller, T.J., and Y.S. Kim. Preparation of Ni, Zn-Doped Lithium Ferrite by Liquid Drying. Bull. Am. Ceram. Soc., v. 54, No. 3, March 1975, pp. 307–309.

[20] Bolle, D. M., and L. R. Whicker, Annotated Literature Survey of Microwave Ferrite Materials and Devices. IEEE Trans. on Magnetics, v. MAG-11, No. 3, May 1975, pp. 907–926.

Iron and Steel

By Horace T. Reno [1]

The world steel industry produced only 713 million tons of raw steel in 1975, 9% less than the quantity produced in 1974. Among the principal producers only the centrally planned economies, the U.S.S.R., and the People's Republic of China, produced more steel in 1975 than in 1974.

The high level of domestic steel output of 1974 carried through into the first quarter of 1975, slowed only by a shortage of natural gas at some midwestern mills. By the second quarter, most domestic mills had begun to cut back, and by the end of May all were operating well below capacity. Through the remainder of the year the industry reached the May level of output in only 1 week. The steel industry produced 117 million tons of raw steel [2] and shipped 80 million tons. The rate of consumption was obscured by wide changes in consumers' and producers' inventories. Consumers' inventories at the end of the year were 3.4 million tons below the February high. Service center inventories at the end of the year were 1.3 million tons below the April high. Steel producers' stocks at the end of 1975 totaled 16.7 million tons, up 3.7 million tons from a January low of 13 million tons.

There was an imbalance between supply and demand at the end of 1974, but by the end of the first quarter of 1975, most steel mill products were readily available and by the end of the second quarter only a few foundry products were still in short supply. According to the American Iron and Steel Institute (AISI) steel mill shipments to service centers and distributors comprised 19% of the total compared with 21% in 1974. Shipments of construction and contractors products comprised 16% of the total compared with 17% in 1974. Shipments to the transportation industries; automotive, rail, marine, and air, comprised 25% of the total compared with only 22% in 1974. Shipments to other markets were essentially unchanged from the proportions shipped in 1974.

Environmental control and noise abatement received much attention during the year. Steel companies operating on the shores of Lake Michigan, in a court settlement, agreed to install water recycling equipment and to stop dumping sludge and solid waste into the Indiana Harbor ship canal. Following air pollution control controversies, several steel companies closed down open hearth steelmaking furnaces rather than expend the funds necessary to control emissions. The Department of Labor held public hearings on its plan to limit noise level at industrial plants. About the same time, the Occupational Health and Safety Administration proposed to continue a 90-decibel limit on noise, but officials of the Environmental Protection Agency, strongly supported by organized labor, demanded a lower limit of 85 decibels. The regulations were not changed during the year. The AISI released a comprehensive study of the total capital requirements for the iron and steel industry to meet pollution control replacements and expansion costs.[3] The pollution costs estimated at $4.1 billion through 1977 were in agreement with most private studies.

According to AISI, the steel industry had an average of 433,800 employees in 1975 compared with an average of 512,400 in 1974. Wages averaged $10.59 per hour

[1] Physical scientist, Division of Ferrous Metals.

[2] The term raw steel, as used by the American Iron and Steel Institute, includes ingots, steel castings, and continuously cast steel. It corresponds to the term crude steel as used by the United Nations.

[3] Arthur D. Little, Inc. Steel and the Environment, A Cost Impact Analysis. A report to the American Iron and Steel Institute. May 1975. 334 pp.

in 1975, compared with an average of $9.08 in 1974. The International Labor Organization Iron and Steel Committee, at its ninth session in Geneva, September 16–26, reviewed the relationship of increasing productivity in the steel industry to increasing output of iron and steel and its basic contribution to rising living standards.[4] Increased labor productivity had not offset higher employment costs in all instances. The second largest steel producer in the United States began to phase out all its steel fabricating facilities contending that costs in its shops were substantially higher than those prevailing in plants outside the industry.[5]

Civil rights controversies apparently were ended in the iron and steel industry when nine steel companies set up a $31 million fund to settle civil rights bias suits. The settlement was approved by the Fifth U.S. Circuit Court of Appeals on August 18, 1975.

Table 1.—Salient iron and steel statistics

(Thousand short tons)

	1971	1972	1973	1974	1975
United States:					
Pig iron:					
Production	81,382	88,876	101,317	95,477	79,721
Shipments	81,332	89,053	101,628	95,941	79,240
Exports	34	15	15	101	60
Imports for consumption	306	637	446	342	478
Steel: [1]					
Production of raw steel:					
Carbon	107,007	117,698	132,747	126,608	100,360
Stainless	1,263	1,564	1,889	2,150	1,111
All other alloy	12,173	13,979	16,163	16,962	15,171
Total	120,443	133,241	150,799	145,720	116,642
Index [2]	94.7	104.5	118.5	114.5	--
Capability utilization [3]	--	--	--	--	76.2
Total shipments of steel mill products	87,038	91,805	111,430	109,472	79,957
Exports of major iron and steel products	3,526	3,546	4,962	r 6,992	3,975
Imports of major iron and steel products [4]	18,744	18,158	15,608	16,746	12,488
World production:					
Pig iron	474,000	500,000	552,000	r 565,000	526,000
Raw steel (ingots and castings)	640,000	693,000	r 769,000	r 780,000	713,000

[1] American Iron and Steel Institute. Includes ingots, continuous cast steel, and all other cast forms.
[2] Based on average production in 1967 as 100.
[3] Defined by AISI as the capability to produce raw steel for a full order book based on the current availability of raw materials, fuels, and supplies; and of the industry's coke, iron, steelmaking, rolling and finishing facilities, recognizing current environmental and safety requirements.
[4] Data not comparable for all years.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron totaled 79.7 million tons in 1975, a decrease of 15.7 million tons or 16% less than that produced in 1974. Average production of pig iron per blast-furnace-day increased to 1,837.4 tons compared with 1,735.1 in 1974 and 1,771.7 tons in 1973 according to AISI. A total of 136 furnaces were in blast at the beginning of the year, including 1 that produced ferroalloys. At yearend the total number in blast had decreased to 119 with none producing ferroalloys. There were 199 producing blast furnaces at the beginning of the year, and 196 at yearend, of which 7 were being relined and 2 were rebuilding.

Metalliferous Materials Consumed in Blast Furnaces.—For each ton of pig iron produced in 1975, an average of 1.645 tons of metalliferous materials was consumed in blast furnaces. Total net iron ore consumed in blast furnaces including agglomerates was 124.0 million tons. The total tonnage of iron ore including manganiferous ore consumed by agglomerating plants at or near the blast furnaces in producing 33.9 million tons of agglomerates was 25.9 million tons. The remainder

[4] I.L.O. News 75/20, Geneva, Switzerland. September 1975, 2 pp.
[5] American Metal Market. Bethlehem Steel to Phase Out All Its Fabricating Plants. V. 82, No. 171, Oct. 2, 1975, pp. 1, 20.

consisted of mill scale, coke, limestone, dolomite, and small amounts of other materials. Domestic pellets charged to the blast furnaces totaled 59.4 million tons, and sinter charged was 34.7 million tons. Pellets and other agglomerates from foreign sources added an additional 11.8 million tons.

Blast furnace oxygen consumption totaled 25.9 billion cubic feet in 1975 according to AISI, compared with 25.8 billion cubic feet in 1974 and 21.0 billion cubic feet in 1973.

Data reported to the Bureau of Mines by the iron and steel industry showed that blast furnaces, through tuyere injection, consumed 12 billion cubic feet of natural gas, 3 billion cubic feet of coke oven gas, 295.2 million gallons of oil, 131.8 million gallons of tar, pitch, and miscellaneous fuels, and 154,205 tons of bituminous and 535 tons of anthracite coal in 1975.

PRODUCTION AND SHIPMENTS OF STEEL

The domestic steel industry produced 116.6 million tons of raw steel in 1975, 20% less than the 145.7 million tons produced in 1974. Of the total, 62% was produced by the basic oxygen process (BOP), 19% by open-hearth furnaces and 19% by electric furnaces. Shipments of steel products for the year totaled 80 million tons, 27% less than the 109.5 million tons shipped in 1974. Shipments to the automotive market totaled 15.2 million tons, 20% less than in 1974; shipments to service centers totaled 15.6 million tons, 33% less than in 1974; shipments to the construction industry were down 31%; and those to industrial and electrical machinery and equipment markets were down 24% compared with shipments to these markets in 1974.

Materials Used in Steelmaking.—Metallics charged to domestic steel furnaces in 1975, per ton of steel produced, averaged 1,281 pounds of pig iron, 1,114 pounds of scrap, and 25 pounds of iron ore, including agglomerates. In 1974, comparable quantities were 1,240 pounds of pig iron, 1,143 pounds of scrap, and 25 pounds of iron ore, including agglomerates.

According to AISI, steelmaking furnaces consumed 534,427 tons of fluorspar, 2.1 million tons of limestone, 7.1 million tons of lime, and 0.9 million tons of other fluxes. Oxygen consumption in steelmaking totaled the equivalent of 178.4 billion cubic feet compared with 212.61 billion cubic feet in 1974.

Imports of all steel products were 25% less than in 1974, but imports of alloy steels were up 8%. Exports of steel mill products were down 43% below the quantity exported in 1974.

CONSUMPTION OF PIG IRON

Pig iron consumed in 1975 totaled 76.6 million tons. In steelmaking, basic oxygen converters consumed 59.2 million tons; open hearths, 14.6 million tons; and electric furnaces, 1.0 million tons. An additional 1.8 million tons was consumed by iron foundries and miscellaneous users, principally for charging cupola furnaces. Also, approximately 3.0 million tons in the form of molten metal was used in making ingot molds and direct castings.

PRICES

Prices for steel mill products varied widely from the prices paid for steel moving in international trade. European prices were an estimated $50 per ton below those paid for domestic steel. Japanese price quotations were $25 to $30 per ton over domestic quotations and, judging by the trend in Japanese steel exports, were not discounted significantly.

Domestic prices for steel mill products on the whole were relatively stable throughout the year, but prices for selected alloys and shapes responded to market pressures. The more significant changes were in decreased quoted prices of about 10% for reinforcing bars and small angles, and increases of $20 per ton for some pipe sizes. Prices for stainless steel, sheet and strip, and some alloy steels were subjected to the greatest downward pressures.

Stabilization of domestic steel prices may have been facilitated when it was reported that buyers of foreign steel paid a $1.6 billion premium for steel products imported into the United States in 1974.[6]

Prices of iron and steel products were relatively stable in the first 9 months of the year. The composite average price of all steel products was 12.739 cents per pound at the beginning of the year, and 12.961 cents per pound at the end of the third quarter, but averaged 13.693 cents per pound in the last quarter.

The composite price for pig iron, according to Iron Age, began the year at $180.50 per short ton. It was increased to $187.67 per short ton in February and remained at that figure for the remainder of the year. The Iron Age composite price for finished steel was 12.739 cents per pound at the beginning of the year, increased to 12.928 cents per pound in February, remained unchanged through May, decreased to 12.920 cents in June, decreased to 12.912 cents in July and August, increased to 13.692 cents in September, and reached 15.693 cents per pound at the end of the year. The Iron Age average composite price for finished steel in 1975 was 13.102 cents per pound.

FOREIGN TRADE

In view of the deteriorating international iron and steel market, and wide fluctuations in selling prices, there was considerable discussion of a worldwide steel production and trade agreement by industrialists attending the International Iron and Steel Institute meeting in Mexico. The idea intrigued most of the attendees but extended discussion indicated that such a trade agreement would be impractical. U.S. producers reported that U.S. antitrust laws would not permit them to participate in such a venture, and the nine member nations of the European Coal and Steel Community rejected governmental barriers to trade in steel.

Domestic specialty steel producers were especially concerned with international trade. The Tool and Stainless Steel Industry Committee and the United Steel Workers of America, AFL-CIO, petitioned the U.S. International Trade Commission on August 5, 1975, for an investigation under section 201(b) of the Trade Act of 1974 to determine whether certain grades and shapes of stainless and alloy steels and electrical steels were being imported in the United States in such increased quantities as to be of substantial cause of serious injury or the threat thereof to the domestic industry producing like or directly competitive articles. At yearend the International Trade Commission had not yet submitted its recommendation to the President.[7]

The United States imported 12 million tons of steel mill products valued at $4.5 million in 1975, 25% less in quantity and 19% less in value than imported in 1974. Imports from the European Community countries were 36% below those in 1974, but imports from Japan were only 5% less. Total imports of carbon steel were 26% less in quantity and 10% less in value than in 1974. Imports of stainless steel were 5% less but were valued 10% higher, and imports of alloyed steel were 8% more in quantity and 44% higher in value than in 1974. Among imports of iron products and ferroalloys the widest swings were in bar iron, slabs, blooms, etc., which were 49% less in quantity and 33% less in value than in 1974.

WORLD REVIEW

NORTH AMERICA

Canada.—The Canadian iron and steel industry production pattern lagged about 3 months behind that of the United States. Steel production held up well in the first half of the year, but was down 9% to 10% in the last half. Nevertheless, the industry continued its expansion program and increased raw steel plant capacity from 18.3 to 19.6 million tons. As in the United States, the normal relationship between raw steel production and steel mill shipments was obscured by inventory ad-

[6] U.S. Steel News. Foreign Steel—Bargain or Boomerang? V. 40, No. 5, September–October 1975, pp. 12–14.

[7] Federal Register. International Trade Commission (TA–201–5), Stainless Steel, Alloy Tool Steel and Silicon Electrical Steel. Vol. 40, No. 155, Aug. 11, 1975, p. 33706.

justment. The threat of a labor strike in midyear also affected the relationship between production and shipments. The labor controversy was settled without a strike, and stocks were returned to normal levels in the last quarter.

Shipments of steel mill products to most markets were substantially less than in 1974, but shipments of plate were up 19% from the 1974 level, and shipments of hot rolled sheet and strip were down only 1%. Compared with 1974, shipments of rolled steel products to public and utility construction were up 16%, shipments to operating railways were up 13%, and shipments of pipes and tubes were up 13%. Canadian steel mill products were sold for $20 to $30 per ton under U.S. quoted prices. In the latter part of the year European steel was sold in Canada below domestic prices. This practice led to allegations of dumping, but at yearend the Government had not taken action.

A new 5,000-ton-per-day blast furnace at the Sault Sainte Marie works of Algoma Steel Corp., Ltd. (Algoma) was probably the most significant of the steel mill facilities completed in Canada in 1975. Among the other new facilities Algoma completed a 1,500-ton-per-day coke battery and six soaking pits; the Steel Co. of Canada, Ltd. (Stelco) completed two 75-ton electric arc furnaces, a 3-strand billet caster, and an SL/RN direct reduction plant at its Griffith mine in northwest Ontario. During the year, Stelco allocated most of its capital expenditures to the Greenfield plant at Nanticoke, Ontario. Dominion Foundries & Steel, Ltd. was installing a 5-strand 72-inch tandem cold rolling mill; Sidbec-Dosco, as part of its phase-two expansion program, was installing two 150-ton electric arc furnaces and a second Midrex reduction plant; and Atlas Steel, Div. of Rio Algom was installing one 25-ton and two 60-ton electric arc furnaces which are to replace six existing furnaces at Welland, Ontario.

There was much discussion of the possibility of a major new steelmaking facility in Nova Scotia. The Nova Scotian Government introduced legislation on February 6, 1975, to establish a Government-owned corporation to organize a new steel complex for Cape Breton. The new agency was to operate separately from the existing Sidney Steel Corp., a provincially owned company. On December 16, the premier of Nova Scotia announced that Dominion Foundries & Steel, Ltd. of Hamilton, Ontario; Estel NV Hoesch-Hoogovens of the Netherlands; National Steel Corp. of Pittsburgh, Pa.; and Thyssen International of West Germany were to assist the Province in conducting feasibility studies for a major steel complex in Cape Breton.[8]

The Steel Company of Canada Ltd. SL/RN processing unit at the Griffith mine in Ontario was fired in July 1975, and was the second SL/RN process plant in Canada. The first operated by Falconbridge Nickel Mines Ltd. was abandoned in December 1972 after achieving only 14% of design capacity. The new Stelco plant did not operate a sufficient time in 1975 to evaluate its performance.

The major steel producers of Canada promoted research to reduce Canadian dependence on high-quality metallurgical coal by actively exploring various formed coke processes.

Mexico.—The International Iron and Steel Institute annual conference was held October 13–15 in Mexico City. Steel executives from 31 countries discussed the world's steel markets, energy, economic developments, and the coal industry.

There were no significant changes in the iron and steel production and demand patterns in Mexico in 1975. The industry produced 5.8 million tons of raw steel, only slightly more than in 1974. The Mexican Government has been encouraging expansion of the domestic iron and steel industry. Late in 1974, it authorized accelerated depreciation for the industry.[9]

The Government rejected foreign participation in the Las Truchas steel project. The project will be continued from Mexico's own resources and loans from the World Bank of the United Nations and the Interamerican Development Bank.[10]

A labor strike closed the Fundidora de Monterrey steel plant for the last 2 weeks of the year. The strike was not solved at yearend.

International Finance Corp., a subsidiary of the World Bank, granted a 150-million-peso credit to Mexico's new stainless steel company, Mexinox S.A. The

[8] U.S. Consulate, Halifax, Nova Scotia. State Department Telegram 0421, December 17, 1975, 2 pp.

[9] Diario Official. Circular No. 102X4047, Dec. 13, 1974, p. 4, U.S. State Department Airgram AX 552, Dec. 26, 1974.

[10] American Metal Market. Foreign Participation in Mexico's Las Truchas Steel Project Rejected. V. 82, No. 103, May 28, 1975, p. 6.

World Bank will also take a 45-million-peso equity position in the company. Mexinox plans a 40-thousand-ton annual capacity stainless steel plant in the industrial park at San Luis Potosi.[11]

SOUTH AMERICA

The annual meeting of the Latin American Iron and Steel Conference was held in Lima, Peru, September 22–26. The principal discussion was of plans to increase Latin American steelmaking capacity and work to become self-sufficient in raw materials. There was a great deal of interest in reports on methods to use the low-ranked coals of South America to cut down on imports of high-grade coking coals. Officials were also concerned with the limited supply of iron and steel scrap in South America.

Argentina.—The Argentina steel industry produced 2,428,000 tons of raw steel in 1975 compared with 2,595,000 tons produced in 1974. Acindar Industria Argentina S.A., the private Argentinian steel company, was authorized to build a new steel works at Villa Constitucion in the Province of Santa Fe. The plant will have an anticipated annual capacity of 600,000 tons of raw steel.[12]

Bolivia.—A study to determine the economic feasibility of an iron and steel plant industrial complex was underway in Bolivia but progress had not been reported at yearend.

Brazil.—Industrial activity was about level throughout the year and held up well in comparison with activity in the market-economy industrialized countries of the world.

The slowdown in steelmaking operations around the world apparently benefited Brazilian steel industry. Brazilian steel mills were able to buy all the metallurgical coal that they needed. The industry produced 9,158,000 tons, 11% more than the 8,270,000 tons produced in 1974. Direct reduction plants produced 234,000 tons of sponge iron in comparison with the 155,000 tons produced in 1974.

Despite the need for steel products to support its manufacturing industries, the Brazilian Government imposed restrictive import measures on pig and cast iron, ferroalloys, sponge iron, steel, ingots, and most steel mill shapes.[13]

SIDERBRAS S.A., the Government holding company formed in 1973 as an investment and administrative agent for the Conselho Consultivo da Industria Nacional de Siderúrgica (CONSIDER), reported that the Romanian Government had extended a $150-million credit for steelmaking equipment, for which the purchase of rolling mills for railmaking by Cia. Siderúrgica Nacional (CSN) would be outside Brazil's Stage III expansion program. SIDERBRAS also reported commitments for financing its Stage III expansion program from France of 750 million francs; the United Kingdom, £50 million; West Germany, $100 million; and Japan, about $200 million. The above mentioned countries agreed to 10-year financing, covering 85% of equipment purchases. Commitments for loans of 12 years, covering 90% of purchases, were obtained from Austria, $150 million, and Finland and Spain, although the amounts were not stated.[14]

The Midrex Corp. of the United States announced that it had agreed with Usinas Siderúrgicas de Minas Gerais, S.A. (USIMINAS) to construct two 400,000-ton-per-year Midrex direct reduction modules at Ipatinga, Minas Gerais.[15]

Venezuela.—The Venezuelan iron and steel industry apparently was on the threshold of a multibillion dollar expansion program that could increase its production capacity from the present 1.2 million tons per year to 4.5 million tons per year by 1980, and projected to 15 million tons per year in about 10 years. Nationalization of its iron mines and large profits accumulated from its petroleum producing industry were responsible for this optimistic outlook. Rapid industrialization has caused iron and steel demand to increase faster than the country's ability to produce steel. The excess demand has been met by imports, so a large market for domestically produced steel mill products exists. Moreover, the iron and steel industry provides an investment opportunity from which relatively rapid returns can be expected because the basic tech-

[11] U.S. Consulate, Monterrey. State Department Airgram A-40, June 13, 1975, 1 p.
[12] Mining Magazine. New Steelworks. V. 132, No. 3, March 1975, p. 217.
[13] National Foreign Trade Council. Resolution No. 98. Rio de Janeiro. Mar. 19, 1975, 1 p.
[14] U.S. Embassy, Brasilia. State Department Airgram A-104, June 13, 1975, 4 pp.
[15] Skillings' Mining Review. Usiminas to Construct Two Midrex Direct Reduction Plants. V. 64, No. 38, Sept. 20, 1975, p. 10.

nology is already employed. Thus, steel is more attractive to the Government than petroleum byproducts for which a market would have to be developed and the technical know-how would have to be developed.

Government-financed steel mill expansion was to be principally at the existing national steel plant at Matanzas in Guayana. This plant is administered through the CVG-Siderúrgica del Orinoco S.A. (CVG-SIDOR). The CVG-SIDOR current expansion Plan Four is scheduled to increase the corporation's raw steelmaking capacity at Matanzas to around 5.3 million tons per year. Plant capacity to produce semifinished and finished steel products is to be increased in response to predicted domestic and export demand. As part of this expansion, a contract was signed early in 1975 with VÖEST-Alpine A.G. of Austria to begin constructing pelletizing facilities to produce feed for two pilot reduction units currently under construction.

Venezuela's private sector steel industry was also planning significant major expansion projects. Of the less than 20 leading private industry steel companies, at least 9 have had major expansion projects approved by the National Steel Council (Consejo Siderurgico Nacional) since the council was created by presidential decree April 28, 1974. Among the largest, Siderúrgica Venezolana S.A. (SIVENSA) was involved in a three-stage expansion program to give it a greater degree of vertical integration, and Siderúrgica del Turbio, S.A. (SIDETUR), received approval in March 1975 for expansion of its plant in Barquisimeto to raise its annual steelmaking capacity to 100,000 tons.

The Government apparently was determined to expand local steel markets. A ruling announced by the Ministry of Development stated that by 1985 locally produced parts must account for 90% of the value of any automobile produced in Venezuela. A special provision requires that the motor and drive shaft be produced in Venezuela. The Ministry estimated that new plants required for conversion of the automotive sector would require investment of approximately 2 billion bolivars.[16]

EUROPE

The steel industries of Western European countries were the hardest hit by the worldwide economic recession of all market-economy countries. Eastern European countries, with their controlled economy, were not much affected. The European Community countries produced 138 million tons of steel and other Western European countries produced 33 million tons compared with 172 million tons and 32 million tons, respectively, produced in 1974. The Eastern European countries produced 212 million tons. Thus, the steel industry of Europe produced 383 million tons, 7% less than the 1974 record.

European Community (EC).—It was apparent early in the year that the steel industry of the EC was in trouble when the EC forward program was returned by the European Coal and Steel Consultive Committee for downward revision of the 1975 forecast. There was much discussion of possible international action to fix steel prices and cut back production; EC was under pressure to fix a floor price for steel, but resisted fixed prices though asking for production cutbacks. Community countries expressed concern about U.S. actions in petitioning for countervailing import duties and specialty alloy steel and stainless steel producers petitioning for relief under the Fair Trade Act.

Community officials followed the course of the steel industry closely, and in the last half of the year required that firms producing crude steel supply to them both their planned or estimated production and their actual production of crude steel in the form of ingots, continuous castings, and liquid steel. Estimates and forecasts were to reach the EC by the 25th of the previous month, and actual production was to reach the EC by the 5th of the following month. On June 12, the Community asked that steel production from June through September be cut back 15%.[17] Community steel output was lowest in August, but stabilized in the last months of the year at about 10 million tons per month, 3 million tons per month less than in the same period of 1974.

Under Article 54 of the European Coal and Steel Community Treaty for Safety and Hygiene Purposes, and particularly for the prevention of nuisances, the EC issued guidelines for granting industrial loans at reduced interest rates for invest-

[16] U.S. Embassy, Caracas, Venezuela. State Department Airgram A-208, Nov. 11, 1975, 18 pp.
[17] U.S. Mission to the Economic Community, Brussels. State Department Telegram 5274, June 12, 1975, 2 pp.

ment in environmental control equipment.[18]

France.—The French iron and steel industry was troubled by a low level of production, an excess labor force, and competition that in many instances forced prices below costs. The French Government led the members of the European Coal and Steel Community in pushing for international discipline in the iron and steel market, and petitioned the Community for price controls. Union Sidérurgique du Nord et de l'Est de la France S.A. (Usinor) cancelled all its 1975 investment projects and put its 40,000-man labor force on 32-hour weeks beginning October 1. Other major steel companies followed with similar actions. The industry produced 23,691,000 tons of raw steel, 20% less than the record 29,788,000 tons produced in 1974.

Germany, West.—As in other EC countries, West Germany's steel industry was plagued by a low level of production and declining prices. Moreover, low-priced steel imports cut into the industry's domestic markets and eroded many of its foreign markets. Steel for the transportation and energy markets was the exception. Prices in these markets held up well. The industry invested in capital equipment at about the same rate as in 1974. Raw steel production of 44.5 million tons was 24% less than the record output of 1974.

Italy.—Italy's iron and steel industry produced 24,070,000 tons of steel mill products in 1975, 8% less than the 26,238,000 tons produced in 1974. ITALSIDER, S.p.A. announced a $300,000,000 modernization expansion plan for its Cornigleano complex at Genoa. The Cornigleano plant is the oldest of the ITALSIDER group and one of the principal bases of the Genoa economy. It has been a source of air and water pollution in the Genoa harbor area. As the expansion program includes water treatment and smoke abatement facilities, Genoa's environmental problems should be lessened.[19]

United Kingdom.—Operation of the British steel industry and marketing of its product in 1975 emphasized that the industry is composed of two quite dissimilar parts, the public sector and the private sector. The public sector operated at a large loss and experienced trouble in holding its markets and in producing quality steel to supply all of its customers. The private sector operated profitably, maintained its markets, and in some instances was able to capture new markets by providing fast reliable service. Steel production in 1975 was 22,267,000 tons, 10% less than the restricted output of 24,720,000 tons in 1974.

British Steel Corp. (BSC), wholly owned by the Government, was the operating arm of the steel industry public sector. BSC lost more than $300 million in 1975, and carried an excess labor force of many thousands of workers through the year. Although it has been able to reduce its work force from 260,000 in 1967 to 218,000 in 1975, its labor troubles have increased progressively from 162 worker disputes in 1971 to an estimated 404 disputes in 1975. The corporation planned to lay off 20,000 workers early in 1975, but agreed to a 10,000-worker layoff following labor union objections and after the unions agreed to certain other cost-saving measures. BSC encountered strong price competition in its foreign markets and cut export prices to meet the competition. Inability to supply the domestic market completely forced the corporation to buy foreign steel to maintain its past position. However, labor and financial troubles did not affect BSC's long-term modernization and expansion plans. Its capital expenditures continued at about £300 million per year. The large steel complex at Scunthorpe was basically completed and the steel plants at Ravenscraig and Llanwern were almost completed. A start was made in expanding the plant at Redcar but only in support of the operations at Lackenby. BSC commissioned a 360,000-ton-per-year electric arc furnace steel works at Clydesdale replacing all the open hearths. It commissioned a 400,000-ton-per-year bar mill at Thrybergh and a 5,000-ton-per-day blast furnace at Llanwern. The blast furnace at Llanwern was commissioned, but it was not lit because of labor troubles there. The corporation expended an estimated £15 million for air pollution control equipment in addition to the pollution control facilities constructed coincident with new facilities.

Most BSC research and development in the environmental field was directed to noise control and better lighting. In other research, physical testing dominated. Prin-

[18] European Community, Brussels. State Department Airgram ECA-46, Feb. 3, 1975, 3 pp.
[19] The Financial Times, London. ITALSIDER Expansion. Oct. 10, 1975, p. 22.

cipal among its development projects the corporation planned an £11 million formed-coke pilot plant at its Normandy Park Works.[20]

The private sector operated profitably throughout the year and produced about one-sixth of the total 22 million tons of steel produced in the United Kingdom in 1975. Reportedly, the private sector was able to maintain its markets because of its ability to respond quickly to customers' orders and its flexibility in changing from one type of product to another. Private sector matters for consideration, in addition to the much discussed joint financing of a direct reduction plant, included the possibility of raw materials joint purchase which, if purchased individually, would be in quantities too small to obtain discount prices.

In the specialty and stainless part of the steel industry the private and public sectors were not as far apart. All specialty steel producers wanted to curb imports and both the public and private sector saw the stainless steel market as having great potential for expansion because stainless steel per capita consumption in the United Kingdom was only half that of the United States, West Germany, France, and Italy. The corporation planned expenditures of £100 million for stainless steel plants and some companies in the private sector were equally active.

Western Europe.—*Austria.*—Austria's iron and steel industry, operating at about 70% of capacity, produced 4,484,000 tons of raw steel in 1975, 13% less than the 5,179,000 tons produced in 1974. The industry maintained its full labor force but cut back the working time to 3 to 4 days per week.

In some instances workers were kept on the payroll through a training program in which the full wages were paid workers for each day in training. Domestic prices for steel were increased moderately. Most steel exported went to West Germany where, under a special agreement with the EC, steel sold for consumption in the community countries could not be priced above the level of Austrian domestic prices.

To improve the competitive position of Austria's specialty steel manufacturers in foreign markets, the Austrian cabinet approved retroactively to January 1, 1975, consolidation of the country's three specialty steel producers, Gebrüder Böhler & Co. A.G., Schoeller-Bleckmann Stahlwerke A.G., and Steirische Gussstahlwerke A.G., into a new company named Vereinigte Edelstahlwerke A.G. (VEW).[21]

Portugal.—In April the Portuguese Government nationalized Siderúrgia Nacional Sarl, the only integrated steel company in Portugal. Portugal's two other steel companies, Cia. Portuguesa de Fornos Eléctricos (Electrofornos) and F. Ramada Aços e Industrias, were not affected.[22]

Spain.—Spain's steel industry produced 12,663,000 tons of steel in 1975, only slightly less than the 12,838,000 it produced in 1974. Spain was able to keep its steel mills operating by exporting to other countries, but the general low level of its own economy and that of its customers prevented rapid expansion as visualized in the 1974 plan. However, Echevarría S.A. and Tubacex, among several small steel companies, submitted expansion plans to the Ministry of Industry as part of the 1974 concerted action scheme. There was a great deal of resentment among the EC countries of Spanish steel marketing practices. It is significant that Spain's trade deficit in iron and steel products was greater in 1975 than it was in 1974.

Sweden.—Construction of the 4-million-ton-per-year integrated steel plant at Luleå was started. The Swedish Government first announced plans for this plant in 1973. At that time the estimated cost was between $500 and $600 million.[23] The Swedish steel industry produced 6,185,000 tons of raw steel in 1975, 6% less than it produced in 1974.

Yugoslavia.—The International Finance Corp., an affiliate of the World Bank, together with a group of eight banks approved a $50 million loan for major expansion of Yugoslavia's steel industry.[24]

Eastern Europe.—The Permanent Commission for the Iron and Steel Industry of the Council for Mutual Economic Assistance (CMEA), reported continuing study of means to control pollution by noxious emissions from iron and steelworks, raising of labor productivity in steel mills, develop-

[20] Steel Times. Pilot Plant For Formed Coke. V. 203, No. 2, February 1975, p 155.
[21] U.S. Embassy, Vienna, Austria. State Department Airgram A-161, Apr. 29, 1975, 2 pp.
[22] Metal Bulletin. Portuguese Nationalisation Near. No. 5986, Apr. 29, 1975, p. 39.
[23] U.S. Embassy, Stockholm, Sweden. State Department Airgram A-120, Apr. 25, 1975, 8 pp.
[24] American Metal Market. Yugoslavian Steel Plan Gets Credit. V. 82, No 182, Sept. 19, 1975, p. 8.

ment of automation of production processes and control systems, and establishment of technical specifications for such equipment. A working party of experts from CMEA countries and Yugoslavia studied the operation of refractories in the steelworks of Hungary, East Germany, the U.S.S.R., and Czechoslovakia. The experts advocated monolithic lining of casting ladles and use of the "Orbit" throwing machines manufactured in the U.S.S.R.

U.S.S.R.—The U.S.S.R. continued as the world's leading steel producer, producing 155.4 million tons of raw steel, one-fourth more than was produced in the United States in 1975. Reportedly the Midrex Corp. of the United States signed an operating license agreement with V/O Metallurgimport of the U.S.S.R. for Midrex direct reduction plants having an annual capacity of 5 million tons per year. The Midrex plants are for a proposed steelworks near Kursk on the Lebedinskiy iron ore deposit.[25]

Academicians of the U.S.S.R. Academy of Sciences recommended reorientation and expansion of the Siberian steel industry to fill reasonable proximity requirements for seamless pipe, wide strip rolled steel, and welded pipe.[26] The change recommended would enable the Siberian steel industry better to supply the steel needs visualized for the principal Siberian development projects under the 10th 5-year plan, 1976–80.

AFRICA

Libya.—The Libyan General Corp. for Iron and Steel Projects (GCISP) contracted with Dastur and Co. of India for construction of an integrated iron and steel plant at Misurata.

South Africa, Republic of.—The Government controlled South African Iron and Steel Industrial Corp. Ltd. (ISCOR) lost R35.9 million in fiscal year 1974–75. Losses were attributed to price controls, cost inflation, production difficulties, shortage of skilled staff and of coking coal, high interest on borrowed capital, and startup costs at the corporation's Newcastle mill. As a result, ISCOR revised its future expansion plans downward. Nevertheless, the major expansion program to double steelmaking capacity in the Republic of South Africa by 1980 was still in effect. The Sishen/Saldanha Bay project progressed satisfactorily. The 534 mile rail line and the Saldanha harbor works were nearly completed.[27]

ASIA

As in 1974, most Asian countries except Japan, produced more steel than in 1974. In the aggregate they produced 163 million tons of raw steel compared with 175 million tons produced in 1974.

China, People's Republic of.—Limited information from China indicates that its steel production for local consumption increased 7% over the quantity produced in 1974, and that about 10% of Chinese steel was produced in small local steelworks.

India.—In contrast to the other market-economy countries of the world, India's steel industry was booming through most of 1975. The industry produced 8,663,000 tons of raw steel, 17% more than the quantity produced in 1974. Improved labor-management relations, which led to better utilization of facilities, was the principal factor contributing to the increase. The Government of India announced a long-term wage agreement with the steelworkers which should assure that the improved relations will continue until September 1978.

The demand for steel in India did not keep pace with the increased domestic supply; nevertheless, shortages of some of the more sophisticated steel mill products continued.

There are about 100 "mini" steel mills in India. The increased rate of output in 1975, and hence profitability, did not extend to these plants. The higher costs of small inefficient operations resulted in some of the minimills going out of business.[28]

India's first sponge iron plant was inaugurated at Vijayawada, Andhra Pradesh. The plant was based on an indigenous know-how provided by India's National Metallurgical Laboratory. It was built at a cost of R10 million, adapting an old cement kiln. Reportedly, the plant produces 30,000 tons of sponge iron per year

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[25] Skillings' Mining Review. Midrex Signs Contract for Plants in Russia. V. 64, No. 13, Mar. 29, 1975, p. 18.

[26] U.S. Embassy, Moscow. State Department Airgram A–56, Feb. 21, 1976, 3 pp.

[27] U.S. Embassy, Pretoria. State Department Airgram A–09, Jan. 16, 1976, 4 pp.

[28] U.S. Embassy, New Delhi, India. State Department Airgram A–26, Jan. 30, 1976, 5 pp. State Department Airgram A–323, Oct. 6, 1975, 3 pp.

using a high-grade iron ore and nonbituminous coal.[29]

Iran.—Iranian Government plans to construct iron and steelworks to make Iran a major steel producer progressed steadily. Essentially all activity in 1975 was at the iron and steel industrial complexes at Ahwaz in the southwest, Isfahan in central Iran, and Bandar Abbas on the Persian Gulf. The only integrated steel plant among these complexes is at Isfahan. In the other areas, iron is to be produced in direct reduction plants.

Most of the work in 1975 was at Ahwaz where the Korf and Thyssen companies of West Germany and the Swindell-Dressler Co. of the United States are to build direct reduction plants.

The integrated steel plant at Isfahan was built by the Russians and is owned by the National Iranian Steel Corp. (NISC). NISC and the Soviet Union agreed to expand its annual capacity to 1.9 million tons, by late 1977 through a credit exchange.

At Bandar Abbas a feasibility study to construct a direct reduction plant and steel mill complex was completed. The complex is to be constructed by an Italian consortium.

All direct reduction plants in Iran are owned by NISC, but private industry has equity in the steelmaking and forming facilities.[30]

Japan.—Raw steel production in Japan declined for the second year in a row. The industry produced 112,782,000 tons, 13% less than it produced in 1974. All the major steelmakers raised prices as the cost of both labor and raw materials increased. U.S. coking coal was quoted at $107 per ton at the first of the year, more than twice the average 1974 cost. Japanese labor unions asked for a 29.4% wage increase but accepted 4.8% well within the 15% guideline set in consultation with the Government and in view of the Japanese economy.

According to the Japan Iron and Steel Federation, the industry's operable capacity for raw steel production in March was about 132 million tons per year. It was increased approximately 8.3 million tons during the year; therefore, the industry operated at between 80% and 85% capacity.

Japanese steel industry capital investment was up almost half over the amount invested in 1974 as construction was resumed on work postponed in 1973. There was much discussion of the possibility of the industry expanding overseas to overcome the high costs of imported energy and other raw materials, and Japanese steel officials actively sought ownership interests in foreign iron ore properties.

Japanese steelmakers, in cooperation with the Government, actively promoted research in use of nuclear energy. The Agency for Industrial Science and Technology started construction of a high-temperature heat exchanger and reducing gas generator which are to be used in a nuclear power steelmaking project. Among new steelmaking facilities, Nippon Kokan Kaisha (NKK) began construction of a steel plant on an artificial island in the Bay of Tokyo.[31] The new plant will replace NKK's Keihin steelworks, which is being phased out because of environmental problems. The new plant is expected to produce 6 million tons of crude steel per year by the end of 1978. Funabashi Steel Works, Ltd. put a new 100-ton, 70,000 kilovolt-amphere capacity electric furnace in operation on June 10.[32] Kawasaki Steel Corporation contracted with a subsidiary of United States Steel Corp. to design and build two 235-ton bottom blown oxygen steelmaking (Q-BOP) furnaces. The two Q-BOP furnaces will be the first in Japan.

OCEANIA

Australia.—The Australian steel industry produced 8.6 million tons of raw steel in 1975, only slightly more than the 8.5 million tons produced in 1974. The slight increase in relation to optimistic forecasts was attributed to a declining domestic market and the inability to meet competition in foreign markets. The domestic market decline was caused principally by depressed conditions in the building industry.

A feasibility study for a large steel mill in Western Australia was completed and distributed to members of the international consortium who authorized the work in 1974. Despite the costs escalated by inflation, the study report recognized the viability of the proposed project. Nevertheless, little progress was made in negotiations to

[29] U.S. Consulate, Madras. State Department Airgram A-18, June 11, 1975, 2 pp.

[30] U.S. Embassy, Tehran. State Department Airgram A-57, Mar. 20, 1975, 5 pp.

[31] Mining Magazine. New Steel Plant. V. 132, No. 3, March 1975, p. 219.

[32] Iron and Steelmaker. 100-Ton Electric Furnace Started. V. 2, No. 9, September 1975, p. 7.

activate the project.[33] Hoogoven's Co. of the Netherlands officially withdrew from the consortium.

New Zealand.—The New Zealand Steel Ltd. plant, using a direct-reduction process to produce steel from iron sands, apparently has been operating satisfactorily. Raw steel production in 1975 totaled 204,000 tons compared with the 214,000 tons produced in 1974 and 209,000 tons produced in 1973. Sponge iron production in 1975 totaled 138,000 tons compared with 126,000 tons in 1974 and 78,000 tons in 1973. It was reported that New Zealand Steel Ltd. was in the advanced stages of planning a large expansion project much of which will be directed to increasing the capacity of the direct reduction equipment.[34]

TECHNOLOGY

Environmental matters were of great concern to industrial researchers during the year. Their most pressing problem had to do with emissions from coal coking plants at integrated steel plants and the health hazards associated with coking plant operation. Granite City Steel Div. of National Steel Corp. devised a one-spot coke receiver system which reportedly controlled atmospheric contamination during the period that finished coke was pushed from the oven.[35] The Granite City system provides full enclosure of the coke push between the coke oven and coke receiver car. A large duct connects the car with gas cleaning equipment; thus, the system does not require hand labor in the immediate proximity.

Capture of dust and fume and other emissions from iron- and steelmaking systems has been essentially perfected in the last few years, but these systems added to steel plant solid waste disposal problems. Several methods were devised in 1975 to recycle the newly generated material and, in some instances, recover most of the valuable metals contained in it. McDowell Wellman Engineering Co. of Cleveland, Ohio, developed a process to use steel mill waste products, including flue dust, mill scale, blast furnace sludge, and basic oxygen fume.[36]

The perennial search for better refining techniques and stronger corrosion resistant alloys that would retain their characteristics over a wider range of temperatures continued throughout the world. Among the more significant work reported, researchers in Europe set up a project to develop automatic, nondestructive testing which, if successful, will facilitate alloy development. Inland Steel Co. announced a process for adding lead to steel in a covered ladle rather than to the ingot in production of free machining steels.[37]

Interest in direct reduction continued unabated among those working in iron and steel research and development. Midrex Corp. experimented with the use of coke-oven gas as a substitute for natural gas in its direct reduction process.[38] Sudbury Metals, a subsidiary of Allis-Chalmers Corp. and National Steel Corp., arranged to take over the Falconbridge Nickel Mines Limited nickel-iron pellet plant which had been shut down because of less than satisfactory performance of the Lurgi metallurgical direct reduction process.[39] Sudbury Metals planned to modify the nickel plant to convert iron oxide pellets into metallized iron pellets at the rate of 1,200 tons per day.

Japanese metallurgists reported significant advances in automation and continuous operations in steelmaking at the Sixth Triennial World Congress of the International Federation of Automatic Control held in the United States at the Massachusetts Institute of Technology in August. They reported that all of Nippon Steel Corp.'s 20 blast furnaces are under partial computer control; furthermore, that only a few problems remain to be solved to achieve total automatic control of blast furnace operations.[40] Nippon Steel's Re-

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[33] U.S. Consulate, Perth. State Department Airgram A-14, Oct. 8, 1975, 2 pp.

[34] U.S. Consulate, Auckland, New Zealand. State Department Airgram A-22, Sept. 4, 1975, 2 pp.

[35] Yaeger, D. Granite City Steel Requests Patent on "One-Spot Coke Receiver System." Am. Met. Market, v. 82, No. 112, June 10, 1975, p. 5.

[36] Foundry—Management & Technology. Electric Ironmaking Process Uses Ore or Steel Mill Wastes. V. 103, No. 10, October 1975, pp. 36–38.

[37] Iron and Steel Engineer. New Inland Process Improves Free Machining. V. 52, No. 9, September 1975, p. 85.

[38] Steel Times. Midrex-USIMINAS Agreement. V. 203, No. 6, June 1975, p. 463.

[39] Marston, K. A Cinderella Story From Falconbridge. Financial Times, No. 26,842, Dec. 11, 1975, p. 20.

[40] Larsen, R. Automated Blast Furnace Soon To To Be, Confab Told. Am. Met. Market, v. 82, No. 171, Sept. 4, 1975, p. 2.

search and Development Department reported achieving dynamic control of the basic oxygen furnace at its Nagoya Works.[41] Japanese steelmakers moved closer to a continuous operation through continuous-continuous casting, fully continuous cold-rolling, continuous annealing, and fully continuous rolling of wide flange shapes.[42] The Japanese, however, lost the distinction of having the world's largest blast furnace because No. 9 furnace at Krivoy Rog in the U.S.S.R. with a working volume of 5,000 cubic meters was lit in 1974.

The metric system of measuring steel began in the United States as the United States Steel Corp. announced that it was making a variety of steel mill products available in standard metric sizes.[43]

Bureau of Mines Research.—Bureau of Mines researchers published the results of some of their work in reclaiming solid wastes associated with the iron and steel industries.[44] In experiments at the Bureau's Salt Lake City (Utah) Metallurgy Research Center treating zinc-lead dust from iron foundries, it was determined that controlled vacuum fuming of zinc to produce Prime Western zinc and a lead-rich residue was the most effective treatment. Hydrometallurgical leaching proved unsatisfactory because iron, manganese, and copper were extracted at the same time. In a study of stainless steel furnace flue dust and wastes at the Rolla Metallurgy Research Center, Rolla, Mo., a process was developed for recovering chromium, nickel, and molybdenum in a form suitable for recycling.

At the Bureau of Mines College Park Metallurgy Research Center, College Park, Md., in work to encourage recovery of iron and steel from urban wastes, Bureau of Mines metallurgists evaluated steel made from the ferrous fractions of urban refuse.[45] On a similar project it was shown that chlorination, using organic solid sources of chlorine, reduced the tin concentration in molten iron to acceptable levels.[46] Continuous charging and preheating of prereduced iron ore was described by metallurgists at the Bureau's Albany Metallurgy Research Center, Albany, Oreg.[47] As an extension of this work, the researchers demonstrated on a small scale the feasibility of melting prereduced iron ore pellets in an electric arc furnace to separate the gangue material; feeding the resulting molten metal into an electroslag furnace through a molten flux to produce an ingot of specific steel composition having the desirable properties inherent in a conventional electroslag process. Successful application of this research will advance the mechanics of steelmaking closer to a continuous process.

[41] Nippon Steel News. Nippon Steel Succeeds in Dynamic Control of BOF. No. 68, December 1975, p. 3.

[42] Steel Today and Tomorrow. Continuous Operation in Steelmaking. No. 10, May–June 1975, pp. 8, 9.

[43] Iron Age. Wait for Metric Steel Comes to an End. V. 216, No. 3, July 21, 1975, pp. 37, 38.

[44] Valdez, E. G., and K. C. Dean. Experiments in Treating Zinc-Lead Dusts From Iron Foundries. BuMines RI 8000, 1975, 13 pp.
Powell, H. E., W. M. Dressel, and R. L. Crosby. Converting Stainless Steel Furnace Flue Dusts and Wastes to a Recyclable Alloy. BuMines RI 8039, 1975, 24 pp.

[45] Makar, H. V., R. S. Kaplan, and L. Janowski. Evaluation of Steel Made with Ferrous Fractions From Urban Refuse. BuMines RI 8037, 1975, 26 pp.

[46] Brown, R. E., H. V. Makar and R. J. Divilio. Refining Molten Iron by Sulfide-Forming Slags and Chlorination: Removal of Copper, Tin, and Other Impurities. BuMines RI 8065, 1975, 32 pp.

[47] Tress, J. E., W. L. Hunter, and W. A. Stickney. Continuous Charging and Preheating of Prereduced Iron Ore. BuMines RI 8004, 1975, 10 pp.

Table 2.—Pig iron produced and shipped in the United States, in 1975, by State
(Thousand short tons and thousand dollars)

State	Production	Shipped from furnaces: Quantity	Shipped from furnaces: Value	Average value per ton
Alabama	3,624	3,531	649,271	$183.88
Illinois	5,218	5,212	905,531	173.74
Indiana	15,657	15,648	2,707,967	173.06
Ohio	14,120	13,959	2,529,634	181.22
Pennsylvania	17,366	17,286	2,909,522	168.32
California, Colorado, Utah	4,568	4,550	626,352	137.66
Kentucky, Maryland, Texas, West Virginia	8,857	8,879	1,488,408	167.63
Michigan	7,012	7,000	1,254,952	179.28
New York	3,299	3,175	534,973	168.50
Total	79,721	79,240	13,606,610	171.71

Table 3.—Foreign iron ore and manganiferous iron ore consumed in manufacturing pig iron in the United States, by source of ore

(Thousand short tons)

Source	1974 [1]	1975 [2]
Australia	656	875
Brazil	3,971	3,013
Canada	1,111	972
Chile	253	648
Peru	(3)	240
Venezuela	5,629	2,954
Other countries	1,659	1,408
Total	13,279	10,110

[1] Excludes 20,952 tons used in making agglomerates.
[2] Excludes 15,064 tons used in making agglomerates.
[3] Included in other countries.

Table 4.—Pig iron shipped from blast furnaces in the United States, by grade [1]

(Thousand short tons and thousand dollars)

Grade	1974			1975		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Foundry	7,469	899,580	$120.44	6,699	1,130,694	$168.79
Basic	85,376	11,136,633	130.44	70,072	12,065,060	172.18
Bessemer	1,130	135,510	119.92	1,005	176,254	175.38
Low-phosphorus	112	15,816	141.21	103	18,500	179.61
Malleable	1,408	175,413	124.58	998	163,010	163.34
All other (not ferroalloys)	446	51,192	114.78	363	53,092	146.26
Total	95,941	12,414,144	129.39	79,240	13,606,610	171.71

[1] Includes pig iron transferred directly to steel furnaces at same site.

Table 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, by State

State	Jan. 1, 1975			Jan. 1, 1976		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	7	2	9	7	2	9
California	3	1	4	3	1	4
Colorado	4	--	4	4	--	4
Illinois	10	9	19	9	10	19
Indiana	21	6	27	19	8	27
Kentucky	2	--	2	2	--	2
Maryland	4	6	10	7	3	10
Michigan	9	--	9	8	1	9
Minnesota	--	2	2	--	2	2
New York	7	4	11	5	6	11
Ohio	27	14	41	24	15	39
Pennsylvania	34	16	50	25	25	50
Texas	2	--	2	1	1	2
Utah	2	1	3	2	1	3
West Virginia	3	1	4	3	1	4
Total	135	62	197	119	76	195
Ferroalloy blast furnaces	1	1	2	--	1	1
Grand total	136	63	199	119	77	196

Source: American Iron and Steel Institute.

Table 6.—Iron ore and other metallic materials, coke and fluxes consumed, and pig iron produced in the United States, by State

(Thousand short tons)

State	Metalliferous materials consumed							Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made				Coke and fluxes consumed per ton of pig iron	
	Iron and manganiferous ores		Agglomerates	Net ores and agglomerates [1]	Net scrap [2]	Miscellaneous [3]	Net total				Net ores and agglomerates [1]	Net scrap [2]	Miscellaneous [3]	Total	Net coke	Fluxes
	Domestic	Foreign														
1974:																
Alabama	242	W	3,690	6,130	98	8	6,236	2,589	640	3,874	1.582	0.025	0.002	1.610	0.668	0.165
Illinois	W	W	10,438	11,369	231	301	11,902	4,253	999	7,184	1.583	.032	.042	1.657	.592	.139
Indiana	W	W	24,716	26,067	335	1,439	27,840	9,476	2,234	17,001	1.533	.020	.085	1.638	.557	.131
Michigan and Minnesota	364	22	11,205	11,485	365	364	12,214	4,408	1,000	7,612	1.509	.048	.048	1.605	.579	.131
New York	1,226	468	W	7,130	200	293	7,623	3,016	651	4,671	1.526	.043	.063	1.632	.646	.139
Ohio	4,266	1,544	21,055	26,271	721	1,212	28,204	11,327	3,730	17,464	1.504	.041	.069	1.615	.649	.214
Pennsylvania	4,662	4,942	24,223	33,723	968	1,009	35,700	13,033	2,916	21,695	1.554	.045	.047	1.646	.601	.134
California, Colorado, Utah	4,250	W	W	10,934	170	95	11,199	3,120	1,133	5,094	2.146	.033	.019	2.198	.612	.222
Maryland, West Virginia, Kentucky, Texas	388	3,621	13,813	17,195	219	598	18,011	6,725	1,572	10,882	1.580	.020	.055	1.655	.618	.144
Total	17,708	13,278	121,571	150,304	3,307	5,319	158,929	57,947	[4] 14,875	95,477	1.574	.035	.056	1.665	.607	.156
1975:																
Alabama	93	1,524	4,136	5,686	67	26	5,779	2,328	516	3,624	1.569	0.018	0.007	1.595	0.642	0.142
Illinois	348	11	8,018	8,348	162	187	8,697	3,173	660	5,218	1.600	.031	.036	1.667	.608	.126
Indiana	896	W	23,588	24,499	391	1,077	25,968	8,659	1,944	15,657	1.565	.025	.069	1.658	.553	.124
Michigan and Minnesota	245	W	10,567	10,749	367	304	11,420	4,252	967	7,012	1.533	.052	.043	1.629	.606	.138
New York	625	W	4,137	5,205	183	62	5,449	2,265	512	3,299	1.578	.055	.019	1.652	.687	.155
Ohio	2,782	1,316	17,722	21,431	574	927	22,932	9,853	3,063	14,120	1.518	.041	.066	1.624	.698	.217
Pennsylvania	3,785	3,639	20,129	27,011	941	708	28,660	10,737	2,220	17,366	1.555	.054	.041	1.650	.618	.128
California, Colorado, Utah	1,434	W	6,039	7,411	208	89	7,708	2,713	911	4,568	1.622	.046	.019	1.687	.594	.199
Maryland, West Virginia, Kentucky, Texas	358	2,152	11,672	13,721	251	525	14,497	5,456	1,260	8,857	1.549	.028	.059	1.637	.616	.142
Total	10,566	9,593	106,008	124,061	3,144	3,905	131,110	49,436	[5] 12,053	79,721	1,556	.039	.049	1.645	.620	.151

W Withheld to avoid disclosing individual company confidential data; included in "Total."

[1] Net ores and agglomerates equal ore plus agglomerates plus flue dust used minus flue dust recovered.

[2] Excludes home scrap produced at blast furnaces.

[3] Does not include recycled material.

[4] Fluxes consisted of the following: 6,763 limestone, 7,592 dolomite, and 520 other fluxes excluding 5,256 limestone, 15 burnt lime, 3,844 dolomite, and 288 other fluxes used in agglomerating production at or near steel plants and an unknown quantity used in making agglomerates at mines.

[5] Fluxes consisted of the following: 5,103 limestone, 6,671 dolomite, and 280 other fluxes excluding 4,309 limestone, 26 burnt lime, 3,218 dolomite, and 117 other fluxes used in agglomerating production at or near steel plants and an unknown quantity used in making agglomerates at mines.

Table 7.—Steel production in the United States, by type of furnace[1]

(Thousand short tons)

Year	Open hearth[2]	Basic oxygen converter	Electric	Total
1971	35,559	63,943	20,941	120,443
1972	34,936	74,584	23,721	133,241
1973	39,780	83,260	27,759	150,799
1974	35,499	81,552	28,669	145,720
1975	22,161	71,801	22,680	116,642

[1] Excludes castings produced by foundries not covered by AISI.
[2] Basic and acid open-hearth production data reported separately in previous years.

Source: American Iron and Steel Institute.

Table 8.—Metalliferous materials consumed in steel furnaces[1] in the United States

(Thousand short tons)

Year	Iron ore		Agglomerates		Pig iron	Ferro-alloys[2]	Iron and steel scrap
	Domestic	Foreign	Domestic	Foreign			
1971	308	1,166	294	320	76,422	1,447	r 63,558
1972	236	850	401	192	r 83,243	1,655	r 73,295
1973	163	1,320	656	243	94,883	1,907	83,228
1974	153	1,126	272	302	90,341	1,950	83,249
1975	92	606	553	189	74,783	1,450	65,022

r Revised.
[1] Basic oxygen converter, open-hearth, and electric furnace.
[2] Includes ferromanganese, spiegeleisen, silicomanganese, manganese metal, ferrosilicon, ferrochromium alloys, and ferromolybdenum.

Table 9.—Consumption of pig iron[1] in the United States, by type of furnace

Type of furnace or equipment	1973		1974		1975	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Basic oxygen converter	68,027	69.7	66,614	71.5	59,210	77.3
Open hearth	25,477	26.1	22,507	24.2	14,554	19.0
Electric	1,379	1.4	1,220	1.3	1,019	1.3
Cupola	2,276	2.3	2,123	2.3	1,362	1.8
Air	57	.1	(2)	(2)	(2)	(2)
Other furnaces[3]	402	.4	632	.7	483	.6
Total	97,618	100.0	93,096	100.0	76,628	100.0

[1] Excludes molten pig iron used for ingot molds and direct castings.
[2] Included with "Other furnaces."
[3] Includes vacuum melting furnaces and miscellaneous melting processes.

Table 10.—Consumption of pig iron[1] in the United States, by State
(Thousand short tons)

State	1975
Alabama	3,397
Arkansas	2
California	1,969
Connecticut	11
Georgia	4
Illinois	5,264
Indiana	15,684
Iowa	26
Kansas	4
Kentucky	1,626
Louisiana	(2)
Maine	(2)
Maryland	3,605
Massachusetts	17
Michigan	7,282
Minnesota	31
Missouri	14
Nevada	(2)
New Jersey	31
New York	2,998
North Carolina	10
Ohio	13,649
Oklahoma	6
Pennsylvania	17,642
Rhode Island	3
Tennessee	39
Texas	1,229
Utah	1,505
Virginia	88
Washington	3
West Virginia	2,306
Wisconsin	95
Undistributed[3]	1,098
Total	79,638

[1] Includes molten pig iron used for ingot molds and direct castings.
[2] Less than ½ unit.
[3] Includes Colorado, Florida, New Hampshire, Oregon, South Carolina, and Vermont.

Table 11.—U.S. exports of major iron and steel products

Products	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
SEMIMANUFACTURED										
Ingots and other primary forms:										
Puddled bars and pilings, blocks, lump and other primary forms of iron or steel, n.e.c	1,916	$291	543	$107	38	$18	1,223	$653	320	$83
Blooms, billets, ingots, slabs, sheet bars, and roughly forged pieces	873,526	78,191	415,392	37,860	546,991	63,023	r 804,768	r 147,730	323,320	58,727
Coils for rerolling	14,347	7,646	85,473	13,816	43,702	10,732	149,643	38,760	8,550	4,328
Blanks for tubes and pipes, iron or steel	2,334	271	2,807	311	3,737	394	2,654	420	1,628	160
Total	892,123	86,399	504,215	52,094	594,468	74,167	r 958,288	r 187,563	333,818	63,298
Bars, rods, angles, shapes and sections:										
Wire rods	62,843	8,415	122,894	16,169	89,786	15,303	65,847	17,469	40,616	10,826
Bars, rods, and hollow-drill steel	129,872	38,550	166,794	43,735	239,617	70,368	r 402,996	r 144,384	174,826	83,264
Concrete reinforcing bars	40,540	6,089	22,417	3,141	151,535	29,788	320,272	86,036	65,323	17,175
Angles, shapes, and sections	164,031	33,111	124,825	25,756	272,519	58,708	397,560	109,130	209,998	69,740
Plates and sheets:										
Steel plates	23,353	12,062	15,063	10,262	29,392	17,405	54,791	32,204	29,358	26,923
Steel sheets	583,015	82,982	396,860	66,679	658,430	152,935	r 1,027,369	r 293,110	191,943	85,168
Black plate	85,202	13,527	58,831	8,830	95,272	16,344	81,297	18,708	13,086	2,709
Iron and steel plates, n.e.c	161,921	37,492	198,653	42,184	473,911	97,176	536,337	166,602	278,599	101,980
Tinplate and terneplate	224,120	43,101	290,255	55,272	419,275	95,344	500,939	173,742	266,627	109,671
Tinplate circles, cobbles, strip and scroll	9,716	1,186	4,565	552	24,151	2,678	17,395	2,654	2,837	437
Hoop and strip	129,128	42,619	404,211	76,146	268,762	83,076	394,738	141,894	83,925	62,311
Total	1,613,741	319,134	1,805,368	348,726	2,722,650	639,125	3,799,541	r 1,185,933	1,357,138	570,204
MANUFACTURED										
Rails and railway track construction materials:										
Rails	50,291	8,489	105,396	16,042	108,965	19,184	128,631	26,221	150,670	45,011
Joints and tie plates	8,948	2,563	9,348	2,173	14,302	3,667	34,610	9,301	43,669	14,509
Sleeper and track material of iron or steel, n.e.c	4,599	2,073	4,767	2,231	4,253	2,044	10,002	5,096	15,177	11,038
Wire, cables, ropes, bands, and slings	62,746	38,282	69,819	43,581	88,469	58,639	r 127,622	r 98,844	114,932	106,046
Tubes, pipes, and fittings:										
Cast-iron pressure pipe and fittings	15,481	8,095	32,586	11,399	27,897	13,575	38,857	29,244	38,635	34,632
Cast-iron soil pipe and fittings	8,288	2,813	4,797	1,744	6,208	2,894	13,358	8,496	39,929	29,719
Steel tube and pipe fittings, unions, and flanges	21,707	36,679	17,517	32,001	21,451	40,176	32,055	68,698	30,203	86,498
Steel tube and pipe fittings, welded	10,546	18,306	7,155	14,082	7,621	15,186	12,304	27,668	12,944	42,869
Malleable iron tube and pipe fittings, n.e.c	2,407	2,764	2,282	2,688	3,747	5,449	4,104	5,907	2,300	4,610
Electrical conduit fittings of iron or steel	7,289	8,880	3,907	5,646	4,611	6,710	7,006	10,911	6,548	13,360

Iron tube and pipe fittings, n.e.c	7,820	12,063	8,394	14,535	11,315	20,827	14,150	30,986	19,478	50,427
Seamless tubes and pipe	222,768	99,542	236,633	104,810	376,997	162,263	628,082	513,862	793,638	934,225
Welded, clinched or riveted tubes and pipe	111,564	44,709	187,548	60,504	207,893	77,658	268,353	156,551	255,678	215,608
Finished structural iron and steel	117,275	63,023	89,620	77,989	219,228	153,914	r 294,345	251,688	220,736	312,554
Castings and forgings	295,619	114,320	371,888	129,629	439,298	173,576	481,091	230,540	407,715	269,923
Storage tanks, lined or unlined	15,582	10,494	14,885	9,628	14,804	11,764	29,826	25,153	19,652	20,879
Nails, tacks, staples, and spikes, n.e.c	7,720	5,835	9,045	7,364	12,822	10,928	16,172	14,358	13,740	12,949
Bolts	23,837	23,348	26,062	24,962	31,394	31,677	38,851	44,287	42,800	52,178
Nuts	5,780	9,374	8,845	11,322	10,865	14,613	15,901	22,536	21,740	23,321
Screws, rivets, washers	19,939	27,342	26,401	33,270	32,272	42,850	38,880	58,194	33,859	55,985
Total	1,020,206	538,994	r 1,236,895	605,600	1,644,412	867,594	r 2,234,200	r 1,638,541	2,284,043	2,336,341
Grand total	3,526,070	944,527	r 3,546,478	1,006,420	4,961,530	1,580,886	r 6,992,029	r 3,012,037	3,974,999	2,969,843

r Revised.

Table 12.—U.S. imports for consumption of pig iron, by country

Country	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Algeria	--	--	6,079	$1,381	--	--
Australia	--	--	1,449	184	17,545	$3,038
Belgium-Luxembourg	--	--	--	--	111	26
Brazil	57,634	$2,726	--	--	25,232	2,717
Canada	387,168	26,132	288,955	32,568	224,379	35,393
Colombia	--	--	7,752	966	1,981	269
Czechoslovakia	--	--	395	9	--	--
Finland	--	--	142	28	--	--
Germany, West	62	4	--	--	5,592	899
Guyana	154	10	--	--	--	--
Hungary	--	--	17,367	2,733	55,652	9,225
Japan	--	--	--	--	104,085	12,575
Norway	--	--	--	--	5,512	740
South Africa, Republic of	39	2	--	--	--	--
Sweden	569	51	8,298	989	32,201	3,411
United Kingdom	--	--	11,911	2,180	5,816	1,023
Total	445,626	28,925	342,348	41,038	478,106	69,316

Table 13.—U.S. imports for consumption of major iron and steel products

Products	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Iron products:										
Cast iron pipes and tubes	12,356	$2,516	11,870	$3,923	6,248	$1,873	6,593	$3,053	8,264	$3,945
Malleable cast-iron fittings	11,962	6,164	13,777	7,668	8,493	6,018	6,643	5,765	7,535	6,941
Bars of wrought iron	226	65	386	120	243	84	390	139	200	94
Castings and forgings	12,975	5,219	15,395	6,447	23,059	11,138	35,898	20,371	31,536	21,319
Total	37,519	13,964	41,428	18,158	38,043	19,113	49,524	29,328	47,535	32,299
Iron and steel products:										
Ingots, blooms, billets, slabs, and sheet bars	274,407	37,191	261,694	38,242	172,305	30,801	182,859	42,839	242,833	69,333
Bars of steel:										
Concrete reinforcement bars	514,813	49,809	358,223	34,969	286,428	43,875	477,750	137,286	142,232	26,860
Solid and hollow steel bars	1,027,768	153,831	1,049,173	176,744	954,286	197,426	866,458	301,733	611,503	243,926
Hollow drill steel	2,392	1,088	4,606	1,285	2,637	1,376	2,929	1,819	2,797	2,418
Plates and sheets:										
Black plate	7,452	1,371	2,010	438	3,323	651	8,333	2,352	6,445	1,574
Steel plate	1,572,560	198,952	1,685,654	239,412	1,348,767	216,255	1,729,001	499,862	1,394,484	404,646
Steel sheets	7,746,573	1,069,372	6,959,182	1,043,449	5,837,588	986,676	5,689,737	1,621,105	4,411,404	1,136,183
Plates and sheets of iron or steel	417	550	532	441	709	549	527	350	696	1,142
Plates, sheets and strip of iron or steel [1]	75,970	14,255	64,179	13,945	71,737	16,976	61,407	21,249	65,002	25,527
Strip of iron or steel	114,902	43,678	135,400	51,850	116,415	52,306	98,058	60,834	71,506	54,690
Tinplate and terneplate	417,691	80,595	522,466	107,870	470,345	105,630	318,996	98,349	408,414	170,191
Structural iron and steel	1,637,154	231,060	1,745,696	247,426	1,375,223	228,419	1,229,375	358,640	903,343	274,985
Angles, shapes, and sections	550,350	61,971	562,864	65,598	457,457	63,044	521,622	156,371	167,284	48,719
Wire rods of steel	1,538,288	187,607	1,402,904	188,789	1,416,256	229,258	1,950,628	581,611	1,112,794	349,577
Sheet piling	89,208	10,605	94,781	12,909	81,248	12,303	84,162	19,295	63,734	17,375
Pipes, tubes and fittings	1,888,942	340,425	1,887,376	368,846	1,681,112	383,372	r 1,952,523	748,934	1,778,608	1,021,002
Bail ties of iron or steel	21,047	3,307	17,166	3,067	15,334	3,011	27,452	9,530	16,610	6,272
Steel castings and forgings	12,958	5,275	24,000	9,186	19,020	7,137	13,555	8,358	15,952	11,953
Rails and railway track construction materials	68,863	11,034	74,820	12,350	77,697	14,741	117,478	34,025	175,418	68,018
Wire:										
Round wire	530,194	125,722	522,205	138,618	525,893	173,701	608,888	r 317,361	381,289	232,687
Other wire	135,737	33,464	155,770	43,807	87,740	32,217	93,538	55,230	52,265	38,704
Nails	308,105	60,428	379,912	86,572	345,121	97,332	355,815	167,201	220,984	100,267
Total	18,535,791	2,721,590	17,910,613	2,885,813	15,346,641	2,897,056	r 16,391,091	r 5,244,334	12,245,547	4,306,049
Advanced manufactures:										
Bolts, nuts, rivets and washers	170,966	67,235	206,428	88,259	223,192	129,043	305,418	309,044	194,779	169,142
Grand total	18,744,276	2,802,789	18,158,469	2,992,230	15,607,876	3,045,212	r 16,746,033	r 5,582,706	12,487,861	4,507,490

r Revised.

[1] Includes plates, sheets and strips of iron or steel, electrolytically coated or plated; 1971, 67,359 tons ($11,583); 1972, 58,681 tons ($11,797); 1973, 63,787 tons ($14,020); 1974, 48,945 tons ($14,957); 1975, 56,879 tons ($21,405).

Table 14.—Pig iron:[1] World production, by country

(Thousand short tons)

Country[2]	1973	1974	1975 [p]
North America:			
Canada	10,511	10,386	10,086
Mexico[3]	3,059	3,535	3,264
United States	101,317	95,477	79,721
South America:			
Argentina	886	1,179	1,146
Brazil	[r] 6,098	6,444	[e] 7,420
Chile	505	569	459
Colombia	[r] 299	297	331
Peru	279	334	331
Venezuela	602	600	628
Europe:			
Austria	3,313	3,795	3,368
Belgium	[r] 13,950	14,352	9,982
Bulgaria	1,726	1,635	1,658
Czechoslovakia[4]	9,407	9,816	10,285
Denmark	84	--	--
Finland	1,557	1,503	1,508
France	21,781	24,235	19,284
Germany, East[5]	2,427	2,513	2,707
Germany, West[6]	[r] 40,158	43,853	32,810
Greece[4]	564	551	[e] 550
Hungary	2,301	2,524	2,446
Italy	11,059	12,881	12,512
Luxembourg[5]	5,610	6,027	4,285
Netherlands	5,188	5,300	4,376
Norway[4]	[r] 770	714	703
Poland	8,380	8,437	8,405
Portugal	427	309	303
Romania	6,297	6,703	7,055
Spain	6,913	7,591	7,534
Sweden[3]	3,041	3,500	3,831
Switzerland	29	39	37
U.S.S.R	104,650	108,992	[e] 110,963
United Kingdom	18,385	15,224	13,006
Yugoslavia	2,155	2,344	2,315
Africa:			
Algeria	395	305	[e] 270
Egypt[5]	[r] 441	303	463
Morocco[e]	11	11	11
Rhodesia, Southern[5]	320	330	342
South Africa, Republic of	4,774	5,094	5,807
Tunisia	174	160	164
Asia:			
China, People's Republic of[e 7]	[r] 31,000	[r] 33,000	35,000
India	8,276	8,093	9,231
Iran	441	1,653	[e] 1,100
Israel[e]	40	40	40
Japan	99,216	99,690	95,765
Korea, North[e 7]	3,000	3,100	3,200
Korea, Republic of	501	1,088	1,308
Malaysia[e]	[r] 220	[r] 250	250
Taiwan	165	123	74
Thailand	16	18	14
Turkey	[r] 1,134	1,452	1,213
Oceania:			
Australia	8,441	7,992	8,241
New Zealand (all sponge iron)[e]	110	140	220
Total	[r] 552,403	564,501	526,017

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Table excludes all ferroalloy production except where noted.

[2] In addition to the countries listed North Vietnam and Zaire presumably have facilities to produce pig iron, but available information is inadequate to make reliable estimates of output levels.

[3] Includes sponge iron output as follows in thousand short tons: Mexico 1973—831; 1974—990; 1975—1,006; Sweden: 1973—209; 1974—217; 1975—240.

[4] May include blast furnace ferroalloys.

[5] May include ferroalloys.

[6] Includes blast furnace ferroalloys except ferromanganese, ferrosilicon and speigeleisen.

[7] Includes ferroalloys.

Table 15.—Raw steel:[1] World production by country

(Thousand short tons)

Country [2]	1973	1974	1975 p
North America:			
Canada	14,755	15,017	14,357
Cuba	244	265	287
Mexico	5,247	5,663	5,787
United States [3]	150,799	145,720	116,642
South America:			
Argentina	2,430	2,595	2,428
Brazil [4]	7,881	8,270	9,158
Chile	605	700	538
Colombia	r 399	367	403
Peru	392	496	488
Uruguay	13	16	18
Venezuela	1,172	1,166	1,185
Europe:			
Austria	4,672	5,179	4,484
Belgium	r 17,115	17,890	12,772
Bulgaria	2,476	2,412	2,464
Czechoslovakia	14,504	15,036	15,780
Denmark	r 495	590	616
Finland	1,780	1,825	1,784
France	27,849	29,788	23,691
Germany, East	r 6,494	6,796	7,104
Germany, West	54,587	58,678	44,550
Greece	830	675	e 675
Hungary	r 3,667	3,823	4,023
Ireland	128	121	90
Italy	23,143	26,238	24,070
Luxembourg	6,530	7,108	5,098
Netherlands	6,200	6,437	5,316
Norway	r 1,048	1,054	1,008
Poland	15,495	16,055	16,542
Portugal	r 553	427	474
Romania	8,996	9,744	10,362
Spain	r 11,914	12,838	12,663
Sweden	6,243	6,602	6,185
Switzerland	644	653	464
U.S.S.R	144,909	149,914	155,426
United Kingdom	29,375	24,720	22,267
Yugoslavia	2,950	3,126	3,214
Africa:			
Algeria	435	496	496
Egypt	r 320	e r 441	384
Morocco e	3	3	3
Rhodesia, Southern e	r 330	r 375	385
South Africa, Republic of	6,135	6,356	7,175
Tunisia	150	145	143
Uganda	17	17	17
Asia:			
Bangladesh	r 67	87	e 93
Burma e	22	22	22
China, People's Republic of e	30,000	30,000	32,000
India	7,678	7,380	8,663
Iran	220	r 440	660
Israel e	r 132	132	143
Japan	131,530	129,115	112,782
Korea, North e	2,900	3,000	3,100
Korea, Republic of	1,276	2,133	2,215
Lebanon e	17	17	17
Malaysia	220	220	254
Philippines e	r 132	r 143	143
Singapore	225	e 240	e 240
Taiwan	559	628	573
Thailand	e 210	243	260
Turkey	1,282	1,608	e 1,590
Oceania:			
Australia	8,470	8,548	8,613
New Zealand	r 209	214	204
Total	r 769,073	780,007	712,588

e Estimate. p Preliminary. r Revised.

[1] Steel formed in first solid state after melting suitable for further processing or sale.

[2] In addition to the countries listed North Vietnam produces raw steel, but information is inadequate to make reliable estimates of output levels.

[3] Data from American Iron and Steel Institute (AISI). Excludes steel produced by foundries not reporting output to AISI but reported to Bureau of Census as follows (in thousand tons): 1973—1,894; 1974—r 2,091; 1975—1,935.

[4] Ingots only.

Iron and Steel Scrap

By D. H. Desy [1]

Reflecting general worldwide business conditions, domestic consumption of iron and steel scrap fell by 22% compared with 1974 consumption. The high scrap consumption rates of 1974 continued into the first quarter of 1975, then declined during the remaining three quarters of the year. Consumer receipts of scrap from brokers, dealers, and other outside sources in 1975 were 31% below those for 1974. Five hundred and sixteen thousand tons of direct-reduced (prereduced) iron was consumed as a substitute for scrap by steelmakers and foundries.

Legislation and Government Programs.— Several bills to amend or extend the Solid Waste Disposal Act were introduced in the Senate and House of Representatives, and a number of these were discussed in committee hearings of the House but no new legislation was passed during the year. The Senate and House of Representatives both passed bills dealing with railroad freight rates, including sections that would require the Interstate Commerce Commission to conduct an investigation of discriminatory freight rates for the transportation of recyclable or recycled materials. By yearend the Senate and House had agreed on the joint conference report.

Table 1.—Salient iron and steel scrap and pig iron statistics in the United States
(Thousand short tons and thousand dollars)

	1974	1975
Stocks Dec. 31:		
Scrap at consumer plants	8,408	8,766
Pig iron at consumer and supplier plants	763	1,435
Total	9,171	10,201
Consumption:		
Scrap	105,483	82,331
Pig iron	96,792	79,638
Exports:		
Scrap (excludes rerolling material and ships, boats, and other vessels for scrapping)	8,497	9,442
Value	$823,720	$762,976
Imports for consumption:		
Scrap (includes tinplate and terneplate scrap)	201	305
Value	$27,027	$25,250

AVAILABLE SUPPLY

The new supply of iron and steel scrap available for consumption at consumers' plants in 1975 was 82.8 million tons. It consisted of 46.0 million tons of home scrap and 36.8 million tons of purchased scrap (net receipts). Compared with 1974 figures, home scrap production was down 16.7% and net receipts were down 28.0%.

[1] Physical scientist, Division of Ferrous Metals.

CONSUMPTION

Consumption of iron and steel scrap in 1975 was 82.3 million tons, 22.0% less than in 1974. Manufacturers of pig iron and steel ingots and castings took 62.8 million tons, or 76.3% of the total. Iron foundries and miscellaneous users consumed 16.3 million tons or 19.8%, and manufacturers of steel castings consumed the remainder.

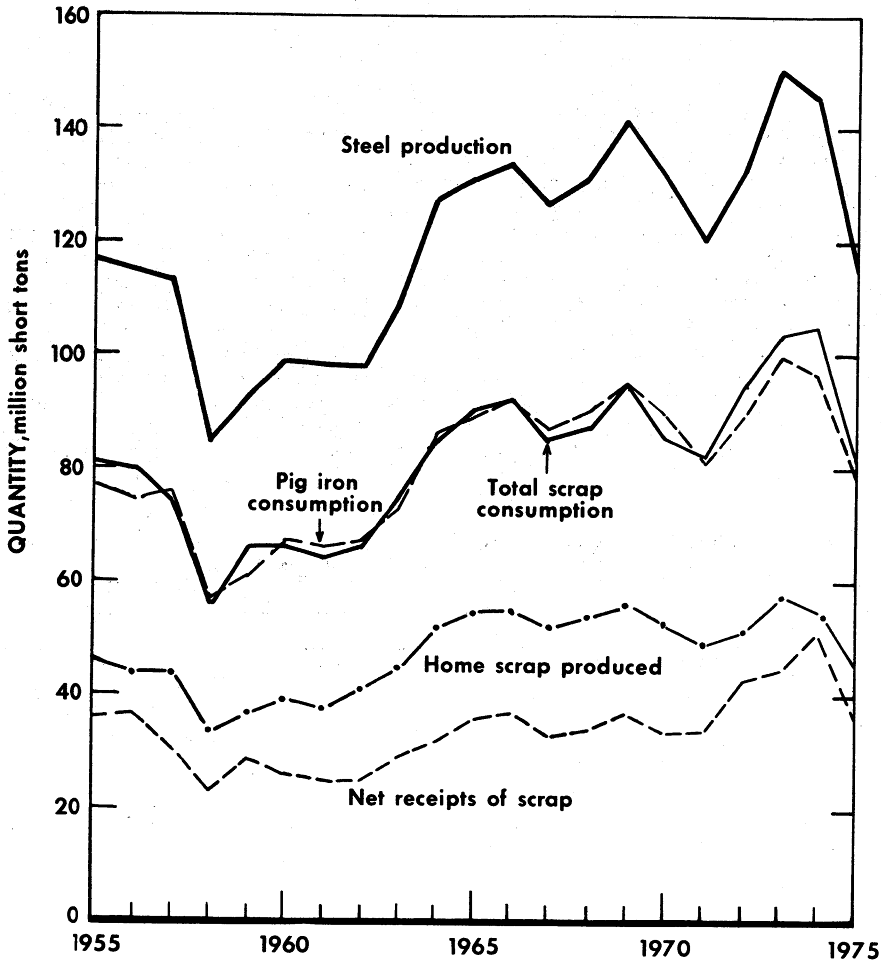

Figure 1.—Steel production (AISI), total iron and steel scrap consumption, pig iron consumption, home scrap production, and net scrap receipts.

STOCKS

Consumers' stocks reported on hand as of December 31, 1975, were 8.8 million tons, up 4.3% from 8.4 million tons at the end of 1974.

PRICES

The Iron Age composite price for No. 1 heavy melting steel scrap (Chicago, Pittsburgh, and Philadelphia) rose from $76.83 per long ton at the beginning of January to a high of $86.50 in April, declined to $58.50 in November, and rose again by yearend. The price at the end of December 1975 was $68.17, 11% below the price of $76.83 at the end of 1974.

FOREIGN TRADE

Exports of iron and steel scrap (excluding rerolling material, and ships, boats, and other vessels for scrapping) amounted to 9.4 million tons in 1975, 11.1% more than the 8.5 million tons exported in 1974.

Japan was the largest importer of U.S. scrap, taking 25.5% of the total in 1975. The next largest shares went to Spain, with 18.1%, and Mexico, with 13.4%.

No. 1 heavy melting steel scrap continued as the largest export grade, accounting for 29.3% of the total. Next largest export grades were shredded steel scrap and No. 2 bundles, which accounted for 25.5% and 12.3%, respectively.

WORLD REVIEW

Belgium.—Steel production in Belgium declined 30% from that of 1974, and this was reflected by decreases in scrap purchases and consumption. Total ferrous scrap consumption in Belgium in 1975 was 4.1 million tons, down 24.7% from the 1974 figure of 5.4 million tons. Imports (including Luxembourg) were 779,000 tons of which 769,000 tons came from European Community (EC) countries. Exports (including Luxembourg) amounted to 586,000 tons of which 525,000 tons went to EC countries. Imports and exports declined by 19% and 27% respectively, compared with 1974 figures.

Brazil.—Demand for ferrous scrap fell off in 1975, and prices paid were generally about 30% below the ceiling prices established by the Government. Brazil had excess scrap processing capacity in 1975, because of equipment bought in 1973 and 1974 in anticipation of increased steel production. Import controls on ferrous scrap were imposed by the Government for the past few years. A new organization of scrap dealers and processors was formed in May 1975, known as the National Institute of Ferrous Scrap Preparation Enterprises (INESFA), and now has 58 members in Brazil.

Canada.—Export controls on ferrous scrap were removed on January 16, 1975, but licensing of exports remained in effect. Exports in 1975 increased by 59% over those of 1974 to 463,000 tons. Exports to the United States amounted to 346,000 tons, an increase of 61% over the quantity for 1974. Imports, at 1,024,000 tons, were up 21% from those of 1974. Virtually all ferrous scrap imports came from the United States. Canada's net imports of scrap from the United States have shown a general declining trend in the past 5 years.

Czechoslovakia.—Raw steel production in 1975 was 15.8 million tons, 5% higher than in 1974, and total scrap consumption was 7.9 million tons, up 3% over 1974 consumption.

France.—Ferrous scrap consumption in 1975 declined by 20% from 1974 figures, amounting to 8.3 million tons. Imports, at 305,000 tons, were 16% less than in 1974, and exports were 25% less, amounting to 3.1 million tons. Over 95% of scrap trade was with EC nations. Of the exports to EC, 2.3 million tons, or 80% went to Italy.

Germany, West.—Reflecting the worldwide recession in the steel industry, exports of ferrous scrap amounted to 2.4 million tons, 13% less than in 1974, and imports were 1.9 million tons, 5% less than in 1974. Imports from EC countries decreased by 13% to 1.6 million tons. Decreased production by steelworks and foundries, which were 24% and 25% less than in 1974, respectively, also affected scrap consumption. The steelworks consumed 23% less scrap than in 1974. Scrap purchased by steelworks amounted to 7.9 million tons, or 20% less than in 1974, whereas foundries purchased 5% less, or 2.1 million tons.

India.—The scrap industry in India is mainly labor-intensive. Almost 80% of all scrap is handled manually from the point where it is generated to the consuming works. Scrap processing facilities in India, which handle only 20% of the scrap turnover, consist of one fragmentizer, about 15 briquetting presses, 40 to 50 mechanical and hydraulic presses, 25 to 30 turnings crushers, and a number of alligator shears. Most scrap processing equipment is based in port cities such as Bombay, Calcutta, and Madras. Heavy melting scrap is segregated by hand, sheet cuttings are tied into bundles manually, and swarf is manually sieved. Even iron and steel skull scrap is broken by hammer and chisel. Because of a shortage of processing capacity, India plans to import about 50 briquetting presses and 75 baling presses. The integrated steel plants in India make up their scrap charge requirements solely from recirculated scrap. Purchased scrap is used by electric furnace plants and rerollers. Under scrap export restrictions, only about 100,000 tons per year of lower grade scrap can be exported.

Japan.—Japan's imports of ferrous scrap declined to 3.4 million tons in 1975, 13% less than in 1974. Imports from the United States in 1975 were 2.4 million tons, 19% less than in 1974. In the second half of 1975, imports from the United States declined by 36%, compared with those of the first half year.

Spain.—Total consumption of scrap in 1975 was 7.4 million tons, 10% less than in 1974. Imports amounted to 866 million tons, of which 66% came from the United States, 25% from EC countries, and the remainder from other countries. Shipbreaking was an important source of scrap. A recent study of the capacity of Spanish shipbreaking yards gave the following estimates by area: Galicia-Asturias, 159,000 tons; Santander, 386,000 tons; Vascongadas, 231,000 tons; Cataluna, 247,000 tons; and Levante, 540,000 tons, for a total of 1,563,000 tons.

Taiwan.—Shipbreaking berths have been expanded from 12 to 48; as a result, it is expected that more scrap will be generated from shipbreaking than can be consumed domestically, and the excess will be exported.

United Kingdom.—Since attaining full membership in EC, the United Kingdom may now export and import ferrous scrap freely with other members of EC. However, exports to third countries outside EC are subject to quotas, as they are for all other members of EC. The British Steel Corporation (BSC) proposed a system for dealing with the scrap industry whereby the number of firms dealing directly with BSC would be reduced from approximately 300 to 30 or 40. Other dealers wishing to sell to BSC would be obliged to do so through one of the direct dealers. In addition to the larger dealers, several consortia of medium-sized dealers were expected to be set up to deal directly with BSC. The plan was expected to be put into effect in the spring of 1976. The BSC was building a stockpile of 1.5 million tons of ferrous scrap during 1975.

A new company was formed to recover tin and steel from tin cans recovered from municipal waste. Known as Material Recovery Ltd., the company was organized by Metal Box Ltd., the United Kingdom's leading canmaker, Batchelor Robinson and Co. Ltd., the leading detinner, and BSC. The plant will be set up at the refuse transfer station at Benwell, Newcastle-on-Tyne. After magnetic separation, the cans will be shipped to the Hartlepool plant of Batchelor Robinson where they will be cleaned and detinned. The detinned scrap will be baled and shipped to BSC. The plant could eventually yield 6,000 tons per year of scrap.

TECHNOLOGY

The number of automobile shredders in the United States continued to increase. Approximately 150 shredders were operating at yearend and about 50 others were ordered or being installed. The total amount of shredded scrap consumed domestically or exported was 5.15 million tons, 2% less than in 1974. Environmental factors influenced the operation of most shredders. Air cleaners are required to collect the light fraction of the shredded automobiles, consisting mainly of fabric, insulating material, and foamed plastic. Noise and vibration were controlled in one installation by supporting the shredder on air bags.

A few plants for the recovery and separation of the nonferrous metal fraction of automobile shredder residues were in operation during the year. To operate economically, such plants must receive residues from several shredders. It is estimated that around 20 plants would be required to handle all the residues from U.S. shredders. Some of the plants operating are using separation methods based on research conducted by the Bureau of Mines.[2]

Hot briquetting as a means of handling turnings and borings gained in importance during the year. The advantages over the cold briquetting method include a product that is denser and more durable and is free from moisture and oil.

Hydraulic cranes are rapidly gaining in popularity over the traditional cable-controlled crane. The hydraulic cranes may be equipped with grapple or electromagnet, and are particularly well suited for feeding scrap processing equipment. Among their advantages are greater speed, accuracy, and mobility, less damage caused to tracks and railroad cars, and less operator training required. Hydraulic shears and bailer-shears are also gaining in popularity. The trend is to larger machines, which can flatten and shear an entire car body.

A cryogenic method for processing whole cars, including engine, transmission, and wheels has been developed in Liège, Belgium, in the past 5 years. The automobile is bailed and cooled to liquid nitrogen temperature (−196°C) in a cooling tunnel. At this temperature, steel is embrittled so that it is easily reduced to small pieces in a fragmentizer. Rubber and plastics are also embrittled and reduced to gravel-size chips. The resulting product is separated by magnetic and density methods.

At the Bureau of Mines' Twin Cities (Minn.) Metallurgy Research Center, research is continuing on utilizing the sensible heat in the offgas produced during oxygen blowing of an experimental basic oxygen furnace to preheat the scrap to be used in the next heat of metal. Previous work had shown that up to 40% of preheated scrap could be used in the furnace charge, with a saving of up to 44% of the energy required to melt the scrap. The effects of varying the operating conditions were being determined in 1975. In another project at Twin Cities, mixtures of raw refuse scrap and shredded automobile scrap were melted in a cupola to produce gray cast iron. Cupola operation and iron quality were satisfactory with proportions of ferrous refuse scrap of up to 60%. The aluminum content of the refuse scrap tended to reduce the sulfur content of the iron and increase silicon recovery.

Research at the Bureau's College Park (Md.) Metallurgy Research Center in cooperation with the Albany (Oregon) Metallurgy Research Center and National Steel Corporation, was conducted to determine problems associated with the use of ferrous fractions from urban refuse as melting stock for steelmaking, and to evaluate the resulting steel products.[3] Fifty-pound ingots from laboratory melts and from 1-ton electric arc furnace melts were hot rolled to provide material for mechanical and corrosion testing. Most of the ingots were rolled successfully and exhibited acceptable surface and edge conditions. Tensile strengths were not significantly affected by copper content up to 0.65% or by tin content up to 0.16%. Yield strength increased with increasing copper and tin contents, and impact strength decreased with increasing tin content. In general, properties of the steel produced were not significantly affected by charge composition, melting practice, or method of scrap preparation.

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[2] Froisland, L. J., K. C. Dean, Leroy Peterson, and E. G. Valdez. Recovering Metal from Nonmagnetic Auto-Shredder Reject. BuMines RI 8049, 1975, 18 pp.

[3] Makar, H. V., R. S. Kaplan, and L. Janowski. Evaluation of Steel Made With Ferrous Fractions from Urban Refuse. BuMines RI 8037, 1975, 26 pp.

The Bureau's Rolla (Mo.) Metallurgy Research Center, with the cooperation of the Twin Cities Metallurgy Research Center and Union Carbide Corp., continued their research to recover iron, chromium, nickel, manganese, and molybdenum from wastes generated by stainless steel producers. These wastes, which included argon-oxygen process dust, electric furnace dust, grinding swarf, and mill scale, were pelletized with coke breeze as a reductant and portland cement as a binder. The laboratory-scale process has been described in a Bureau publication.[4] In a 2,000-pound heat, recoveries of iron, chromium, and nickel were 89%, 81%, and 82%, respectively, and an ingot having the composition 65% iron, 14% chromium, and 6% nickel, with smaller quantities of manganese and molybdenum, was produced. This product can be recycled to the steel furnace. Some steel companies have used this process experimentally and several companies were planning to use it on a commercial basis.

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[4] Powell, H. E., W. M. Dressel, and R. L. Crosby. Converting Stainless Steel Flue Dust and Wastes to a Recyclable Alloy. BuMines RI 8039, 1975, 24 pp.

Table 2.—U.S. consumer receipts, production, consumption, shipments and stocks of iron and steel scrap in 1975, by grade

(Thousand short tons)

Grade of scrap	Receipts of scrap: From brokers, dealers and other outside sources	Receipts of scrap: From other own-company plants	Production of home scrap: Recirculating scrap resulting from current operations	Production of home scrap: Obsolete scrap (includes ingot molds, stools, and scrap from old equipment, buildings, etc.)	Consumption of both purchased and home scrap (includes recirculating scrap)	Shipments of scrap	Ending stocks Dec. 31
MANUFACTURERS OF PIG IRON AND STEEL INGOTS AND CASTINGS [1]							
Carbon steel:							
Low-phosphorus plate and punchings	714	11	24	(2)	733	(2)	106
Cut structural and plate	235	3	274	9	478	56	20
No. 1 heavy melting steel	4,985	2,363	16,878	138	22,205	1,961	2,504
No. 2 heavy melting steel	1,909	101	902	2	3,064	54	462
No. 1 and electric furnace bundles	5,153	445	2,283	7	7,597	64	1,082
No. 2 and all other bundles	1,847	108	240	(2)	2,324	98	353
Electric furnace 1 foot and under (not bundles)	78	1	53	--	133	1	10
Railroad rails	50	(2)	(2)	(2)	42	6	5
Turnings and borings	1,153	100	356	1	1,608	92	80
Slag scrap (Fe content 70%)	1,418	63	2,688	--	4,082	101	263
Shredded or fragmentized	1,512	412	51	(2)	2,014	8	163
All other carbon steel scrap	2,323	151	9,997	82	11,536	734	788
Stainless steel scrap	237	31	444	5	687	48	124
Alloy steel (except stainless)	149	183	1,717	8	1,869	87	315
Ingot mold and stool scrap	388	404	857	1,354	1,982	612	794
Machinery and cupola cast iron	7	--	--	1	8	--	(2)
Cast iron borings	343	366	733	28	1,271	96	200
Motor blocks	11	2	2	(2)	14	(2)	1
Other iron scrap	349	126	708	57	923	337	183
Other mixed scrap	98	90	161	(2)	266	88	127
Total scrap [3]	22,959	4,960	38,367	1,693	62,836	4,442	7,581
MANUFACTURERS OF STEEL CASTINGS [4]							
Carbon steel:							
Low-phosphorus plate and punchings	661	5	219	5	878	(2)	73
Cut structural and plate	193	28	22	(2)	248	1	20
No. 1 heavy melting steel	155	8	80	(2)	244	(2)	31
No. 2 heavy melting steel	32	--	13	--	49	(2)	3
No. 1 and electric furnace bundles	57	(2)	(2)	--	54	(2)	5
No. 2 and all other bundles	10	--	--	--	11	(2)	1
Electric furnace 1 foot and under (not bundles)	76	2	18	(2)	89	8	6
Railroad rails	4	--	--	--	6	(2)	1
Turnings and borings	67	1	25	2	83	11	9
Slag scrap (Fe content 70%)	7	(2)	7	(2)	14	(2)	(2)
Shredded or fragmentized	82	--	--	--	81	--	5
All other carbon steel scrap	454	13	370	8	852	2	42
Stainless steel scrap	24	8	41	--	68	3	5

See footnotes at end of table.

Table 2.—U.S. consumer receipts, production, consumption, shipments and stocks of iron and steel scrap in 1975, by grade—Continued

(Thousand short tons)

Grade of scrap	Receipts of scrap: From brokers, dealers and other outside sources	Receipts of scrap: From other own-company plants	Production of home scrap: Recirculating scrap resulting from current operations	Production of home scrap: Obsolete scrap (includes ingot molds, stools, and scrap from old equipment, buildings, etc.)	Consumption of both purchased and home scrap (includes recirculating scrap)	Shipments of scrap	Ending stocks Dec. 31
MANUFACTURERS OF STEEL CASTINGS [4]—Continued							
Alloy steel (except stainless)	72	11	129	1	181	34	17
Ingot mold and stool scrap	1	--	(2)	--	3	(2)	1
Machinery and cupola cast iron	24	--	10	(2)	34	(2)	4
Cast iron borings	34	1	42	--	74	1	5
Motor blocks	11	--	--	--	12	(2)	2
Other iron scrap	85	1	94	2	180	4	25
Other mixed scrap	5	--	6	1	12	(2)	(2)
Total scrap [3]	2,054	78	1,075	18	3,173	64	255
IRON FOUNDRIES AND MISCELLANEOUS USERS							
Carbon steel:							
Low-phosphorus plate and punchings	722	85	90	(2)	889	8	71
Cut structural and plate	1,148	108	117	19	1,386	16	90
No. 1 heavy melting steel	265	115	56	(2)	408	48	31
No. 2 heavy melting steel	119	10	29	1	154	1	14
No. 1 and electric furnace bundles	194	158	35	1	406	(2)	9
No. 2 and all other bundles	282	31	8	3	336	4	28
Electric furnace 1 foot and under (not bundles)	230	74	7	--	311	3	6
Railroad rails	84	(2)	6	--	94	(2)	9
Turnings and borings	542	121	16	3	683	28	73
Slag scrap (Fe content 70%)	30	--	1	--	24	1	7
Shredded or fragmentized	610	6	8	--	652	(2)	22
All other carbon steel scrap	944	560	92	(2)	1,618	10	119
Stainless steel scrap	29	(2)	5	(2)	32	(2)	15
Alloy steel (except stainless)	83	2	10	1	90	2	25
Ingot mold and stool scrap	148	2	34	5	183	9	23
Machinery and cupola cast iron	751	88	562	3	1,413	8	74
Cast iron borings	525	632	309	2	1,426	46	72
Motor blocks	561	25	341	(2)	932	3	50
Other iron scrap	1,002	140	2,829	7	3,927	94	160
Other mixed scrap	424	649	282	5	1,358	8	34
Total scrap [3]	8,692	2,806	4,837	51	16,322	290	930
TOTAL—ALL TYPES OF MANUFACTURERS							
Carbon steel:							
Low-phosphorus plate and punchings	2,096	101	333	5	2,500	9	250
Cut structural and plate	1,576	139	414	29	2,112	73	131

No. 1 heavy melting steel	5,405	2,486	17,015	139	22,857	2,009	2,566
No. 2 heavy melting steel	2,060	111	943	2	3,267	55	480
No. 1 and electric furnace bundles	5,404	602	2,318	8	8,057	64	1,096
No. 2 and all other bundles	2,140	138	248	3	2,671	102	381
Electric furnace 1 foot and under (not bundles)	384	78	78	(2)	534	12	22
Railroad rails	138	(2)	6	(2)	142	6	15
Turnings and borings	1,762	222	398	6	2,375	131	162
Slag scrap (Fe content 70%)	1,455	63	2,695	(2)	4,120	102	270
Shredded or fragmentized	2,203	418	59	(2)	2,747	8	190
All other carbon steel scrap	3,722	724	10,460	90	14,006	746	949
Stainless steel scrap	290	39	489	5	787	51	144
Alloy steel (except stainless)	303	196	1,856	10	2,140	122	357
Ingot mold and stool scrap	537	406	890	1,359	2,167	621	818
Machinery and cupola cast iron	782	88	572	4	1,455	8	78
Cast iron borings	902	1,000	1,084	29	2,772	143	277
Motor blocks	583	26	343	(2)	958	3	52
Other iron scrap	1,436	267	3,631	66	5,030	434	367
Other mixed scrap	528	740	449	6	1,636	97	161
Total scrap [3]	33,706	7,843	44,279	1,763	82,331	4,796	8,766

[1] Includes only those castings made by companies producing steel ingots.
[2] Less than ½ unit.
[3] Data may not add to totals shown because of independent rounding.
[4] Excludes companies that produce both steel ingots and steel castings.

Table 3.—U.S. consumer receipts, production, consumption, shipments, and stocks of pig iron and direct-reduced iron in 1975

(Thousand short tons)

	Receipts	Production	Consumption	Shipments	Stocks Dec. 31
MANUFACTURERS OF PIG IRON AND STEEL INGOTS AND CASTINGS					
Pig iron	5,175	79,731	76,834	7,462	1,276
MANUFACTURERS OF STEEL CASTINGS					
Pig iron	52	--	58	1	8
IRON FOUNDRIES AND MISCELLANEOUS USERS					
Pig iron	2,598	--	2,746	18	151
TOTAL—ALL TYPES OF MANUFACTURERS					
Pig iron	7,825	79,731	79,638	7,481	1,435
Direct-reduced or prereduced iron	[1] 515	([2])	516	W	([3])

W Withheld to avoid disclosing individual company confidential data.
[1] Receipts and production combined.
[2] Production included in receipts.
[3] Less than ½ unit.

Table 4.—Consumption of iron and steel scrap and pig iron in the United States in 1975 by type of consumer and type of furnace, or other use

(Thousand short tons)

Type of furnace or other use	Manufacturers of pig iron and steel ingots and castings		Manufacturers of steel castings		Iron foundries and miscellaneous users		Total all types [1]	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
Blast furnace [2]	3,931	--	--	--	--	--	3,931	--
Basic oxygen process [3]	23,392	59,210	--	--	--	--	23,392	59,210
Open-hearth furnace	11,669	14,545	110	9	--	--	11,780	14,554
Electric furnace	23,010	763	2,814	37	4,027	218	29,850	1,019
Cupola furnace	336	167	216	5	11,196	1,191	11,749	1,362
Other (including air furnace) [4]	498	407	32	7	1,100	69	1,629	483
Direct castings [5]	--	1,741	--	--	--	1,269	--	3,010
Total [1]	62,836	76,834	3,173	58	16,322	2,746	82,331	79,638

[1] Data may not add to totals shown because of independent rounding.
[2] Includes consumption in all blast furnaces producing pig iron.
[3] Includes scrap and pig iron processed in metallurgical blast cupolas and used in oxygen converters.
[4] Includes vacuum melting furnaces and miscellaneous uses.
[5] Includes ingot molds and stools.

Table 5.—Proportion of iron and steel scrap and pig iron used in furnaces in the United States

(Percent)

Type of furnace	1975	
	Scrap	Pig iron
Basic oxygen process	28.3	71.7
Open-hearth furnace	44.7	55.3
Electric furnace	96.7	3.3
Cupola furnace	89.6	10.4
Other (including air furnace)	77.1	22.9

Table 6.—Iron and steel scrap supply [1] available for consumption in 1975, by State and region
(Thousand short tons)

State and region	Receipts of scrap: From brokers, dealers and other outside sources	Receipts of scrap: From other own-company plants	Production of home scrap: Recirculating scrap resulting from current operations	Production of home scrap: Obsolete scrap (includes ingot molds, stools, and scrap from old equipment, buildings, etc.)	Total new supply [2]	Shipments of scrap [3]	New supply available for consumption
New England and Middle Atlantic:							
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont	1,463	202	1,469	34	3,168	254	2,914
Pennsylvania	5,280	1,969	10,332	425	18,006	1,632	16,375
Total [2]	6,743	2,171	11,800	460	21,174	1,886	19,288
North Central:							
Illinois	3,925	840	3,578	192	8,536	272	8,264
Indiana	2,088	151	7,598	335	10,172	727	9,445
Michigan, Iowa, Minnesota, Nebraska, Kansas, Missouri	4,983	1,981	3,695	126	10,785	284	10,502
Ohio	5,045	1,670	7,021	304	14,040	878	13,162
Wisconsin	668	48	519	(4)	1,235	17	1,218
Total [2]	16,710	4,691	22,411	957	44,769	2,177	42,592
South Atlantic:							
Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	2,334	296	2,818	237	5,685	73	5,612
South Central:							
Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas	5,105	412	4,495	80	10,093	484	9,609
Mountain and Pacific:							
Arizona, California, Colorado, Montana, Nevada, Oregon, Utah, Washington	2,813	273	2,755	29	5,870	175	5,694
U.S. total [2]	33,706	7,843	44,279	1,763	87,591	4,796	82,795

[1] New supply available for consumption is a net figure computed by adding production to receipts and deducting scrap shipped during the year. The plus or minus difference in stock levels at the beginning and end of year is not taken into consideration.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes scrap shipped, transferred, or otherwise disposed of during the year.
[4] Less than ½ unit.

Table 7.—Consumption of iron and steel scrap and pig iron[1] by State and region, by type of manufacturer in 1975

(Thousand short tons)

State and region	Pig iron and steel ingots and castings		Steel castings		Iron foundries and miscellaneous users		Total[2]	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
New England and Middle Atlantic:								
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont	1,616	2,780	213	9	1,039	274	2,867	3,063
Pennsylvania	14,643	17,015	416	22	1,012	605	16,071	17,642
Total[2]	16,259	19,795	629	31	2,050	879	18,938	20,705
North Central:								
Illinois	6,408	4,956	446	1	1,427	307	8,282	5,264
Indiana	8,305	15,573	196	1	729	110	9,230	15,684
Michigan, Iowa, Minnesota, Nebraska, Kansas, Missouri	5,403	6,894	387	2	4,852	461	10,642	7,357
Ohio	10,237	13,065	305	14	2,520	570	13,062	13,649
Wisconsin	--	--	317	1	903	94	1,220	94
Total[2]	30,353	40,488	1,651	19	10,431	1,542	42,435	42,049
South Atlantic:								
Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	4,753	5,895	88	2	689	126	5,530	6,023
South Central:								
Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas	6,845	6,130	400	1	2,416	167	9,662	6,298
Mountain and Pacific:								
Arizona, California, Colorado, Montana, Nevada, Oregon, Utah, Washington	4,626	4,526	404	6	735	31	5,765	4,563
U.S. total[2]	62,836	76,834	3,173	58	16,322	2,746	82,331	79,638

[1] Includes molten pig iron used for ingot molds and direct castings.
[2] Data may not add to totals shown because of independent rounding.

Table 8.—Consumer stocks of iron and steel scrap, by grade, and pig iron, December 31, 1975, by State and region

(Thousand short tons)

State and region	Carbon steel (excludes rerolling rails)	Stainless steel	Alloy steel (excludes stainless)	Cast iron (includes borings)	Other grades of scrap	Total scrap stocks [1]	Pig iron stocks
New England and Middle Atlantic:							
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont	375	30	14	79	3	500	148
Pennsylvania	1,367	54	149	369	4	1,943	307
Total [1]	1,742	84	163	448	7	2,444	456
North Central:							
Illinois	781	5	14	60	(2)	860	41
Indiana	607	5	80	404	116	1,212	58
Michigan, Iowa, Minnesota, Nebraska, Kansas, Missouri	558	14	1	125	9	707	58
Ohio	868	21	41	215	4	1,149	475
Wisconsin	23	1	(2)	15	(2)	40	10
Total [1]	2,836	46	137	819	129	3,967	643
South Atlantic:							
Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	414	11	10	111	(2)	546	33
South Central:							
Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas	960	1	22	139	21	1,142	268
Mountain and Pacific:							
Arizona, California, Colorado, Montana, Nevada, Oregon, Utah, Washington	560	2	26	76	4	668	36
U.S. total [1]	6,512	144	357	1,592	161	8,766	1,435

[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.

Table 9.—Average monthly price and composite price for No. 1 heavy melting scrap in 1975

(Per long ton)

Month	Chicago	Pittsburgh	Philadelphia	Composite price [1]
January	$79.50	$74.75	$79.75	$78.00
February	79.75	79.50	78.50	79.25
March	84.50	83.10	87.50	85.03
April	83.25	81.50	93.50	86.08
May	77.00	79.00	89.25	81.75
June	63.10	66.50	71.60	67.06
July	54.00	56.50	64.12	58.21
August	68.00	68.50	72.25	69.58
September	76.50	70.30	73.60	73.46
October	65.00	59.50	61.62	62.04
November	60.50	59.50	55.50	58.50
December [e]	64.16	61.83	59.50	61.83
Average 1975 [e]	71.27	70.04	73.89	71.73
Average 1974	112.44	106.21	106.92	108.51

[e] Estimate.
[1] Composite price, Chicago, Pittsburgh, and Philadelphia.

Source: Iron Age, Jan. 5, 1976.

Table 10.—U.S. consumer receipts, shipments, production, consumption, and stocks of iron and steel scrap, 1935–75

(Thousand short tons)

Year	Receipts [1]	Shipments [1]	Production [1] of home scrap	Consumption [2]			Stocks December 31
				Home [3]	Purchased [3]	Total [4]	
1935	--	--	--	14,948	14,637	29,585	NA
1936	--	--	--	21,170	19,552	40,721	NA
1937	--	--	--	22,256	20,311	42,567	NA
1938	--	--	--	12,680	11,226	23,906	5,148
1939	--	--	--	19,622	16,705	36,327	5,310
1940	--	--	--	25,048	19,482	44,530	5,472
1941	--	--	--	33,905	25,312	59,216	3,726
1942	--	--	--	33,129	27,136	60,265	6,316
1943	--	--	--	35,037	26,614	61,651	5,872
1944	--	--	--	35,426	25,923	61,349	4,419
1945	--	--	--	30,961	25,230	56,191	3,924
1946	--	--	--	26,134	23,350	49,484	3,397
1947	--	--	--	31,579	29,285	60,864	4,431
1948	--	--	--	32,420	32,544	64,964	6,458
1949	--	--	--	29,166	25,172	54,338	5,641
1950	--	--	--	35,525	33,376	68,901	5,420
1951	--	--	--	38,857	37,871	76,728	4,366
1952	--	--	--	34,837	34,186	69,023	6,902
1953	--	--	--	--	--	77,131	7,149
1954	--	--	--	--	--	61,354	7,349
1955	38,592	2,857	45,501	--	--	81,375	7,210
1956	39,425	2,579	43,676	--	--	80,315	7,416
1957	33,862	2,776	43,996	--	--	73,549	8,949
1958	25,110	1,819	33,714	--	--	56,360	9,594
1959	31,128	2,085	37,418	--	--	66,062	9,993
1960	28,469	2,374	39,632	--	--	66,469	9,288
1961	27,553	2,248	38,475	--	--	64,327	8,824
1962	27,499	2,215	40,645	--	--	66,160	8,471
1963	32,248	2,816	44,655	--	--	74,621	7,945
1964	36,664	4,833	52,262	--	--	84,626	7,427
1965	41,239	5,435	55,213	--	--	90,359	7,642
1966	42,394	5,723	55,463	--	--	91,583	8,188
1967	37,984	5,330	52,312	--	--	85,361	7,793
1968	39,463	5,876	53,545	--	--	87,060	7,882
1969	43,679	6,750	56,287	--	--	94,816	6,552
1970	39,668	5,520	52,575	--	--	85,559	7,668
1971	r 39,542	r 5,330	r 49,194	--	--	r 82,817	8,494
1972	r 47,241	r 5,500	51,184	--	--	r 93,491	8,169
1973	50,936	r 6,173	r 57,743	--	--	r 103,606	r 7,086
1974 [5]	57,409	6,074	55,250	--	--	105,483	8,408
1975	41,549	4,796	46,042	--	--	82,331	8,766

r Revised. NA Not available.

[1] Not reported before 1955.

[2] Before 1942, does not include consumption for ferroalloys or miscellaneous uses.

[3] Not reported after 1952.

[4] Data may not add to totals shown because of independent rounding.

[5] Augmented reporting panel used beginning in 1974.

Table 11.—U.S. consumption of iron and steel scrap by type of furnace or other use, 1935–75

(Thousand short tons)

Year	Blast	Open hearth	Basic oxygen	Electric [1]	Cupola	Air [2]	Bessemer [3]	Ferroalloy [4]	Other [5]	Total [6]
1935	1,736	21,414	--	1,025	4,658	500	246	--	7	29,585
1936	2,337	29,451	--	1,397	6,512	744	268	--	12	40,721
1937	2,656	29,584	--	1,933	7,288	834	258	--	14	42,567
1938	1,192	16,361	--	1,048	4,695	476	129	--	5	23,906
1939	1,933	25,531	--	1,673	6,415	546	220	--	9	36,327
1940	2,080	31,008	--	2,495	8,030	646	258	--	13	44,530
1941	2,905	39,923	--	4,178	10,564	1,222	393	--	31	59,216
1942	2,938	39,560	--	5,906	9,055	1,141	370	318	978	60,265
1943	3,568	40,214	--	6,914	8,004	1,229	381	377	964	61,651
1944	3,638	40,808	--	6,422	7,543	1,191	387	331	1,029	61,349
1945	3,339	37,756	--	5,083	7,344	1,070	317	312	971	56,191
1946	2,273	32,442	--	3,698	8,559	1,011	243	276	983	49,484
1947	2,692	39,288	--	5,224	10,558	1,310	273	317	1,202	60,864
1948	2,932	40,623	--	6,706	11,467	1,381	251	352	1,252	64,964
1949	3,007	35,522	--	4,697	8,757	901	209	296	949	54,338
1950	4,390	43,512	--	7,323	10,721	1,195	257	355	1,148	68,901
1951	4,478	47,416	--	9,372	12,319	1,432	300	415	998	76,728
1952	4,274	42,997	--	8,973	10,169	1,199	247	340	824	69,023
1953	4,948	49,668	--	9,157	10,634	1,197	276	373	877	77,131
1954	3,628	39,028	(7)	6,832	9,564	962	204	306	831	61,354
1955	4,722	51,555	(7)	9,801	12,058	1,445	418	344	1,031	81,375
1956	4,404	50,806	(7)	11,057	11,025	1,269	413	371	970	80,315
1957	4,171	46,439	(7)	9,939	10,325	1,152	387	338	799	73,549
1958	2,857	34,342	(7)	8,050	8,654	920	631	193	712	56,360
1959	3,189	38,657	581	10,353	10,727	1,272	203	315	765	66,062
1960	3,594	39,613	1,150	9,920	10,045	1,086	147	284	630	66,469
1961	3,551	37,872	1,371	10,103	9,511	985	109	245	580	64,327
1962	3,782	36,784	1,847	10,871	10,710	1,213	104	302	548	66,160
1963	4,306	40,637	2,776	12,935	11,920	1,317	157	345	227	74,621
1964	4,816	43,881	5,486	14,862	13,407	1,441	119	412	202	84,626
1965	5,054	43,725	7,774	16,694	14,781	1,548	80	512	192	90,359
1966	5,226	39,339	11,368	18,002	15,273	1,572	69	560	174	91,583
1967	4,724	33,043	13,932	18,011	13,877	1,100	41	511	122	85,361
1968	4,267	31,619	16,112	19,550	14,776	(8)	(8)	--	736	87,060
1969	4,779	30,706	19,828	23,807	14,978	210	--	--	506	94,816
1970	5,302	22,313	21,124	23,014	12,988	227	--	--	591	85,559
1971	3,708	18,832	20,058	r 24,668	14,806	185	--	--	560	r 82,817
1972	r 3,754	r 19,700	r 23,912	r 29,683	15,544	r 187	--	--	r 711	r 93,491
1973	4,246	20,557	27,318	35,353	15,252	178	--	--	r 702	r 103,606
1974 [9]	4,558	19,159	26,614	37,476	15,640	(8)	--	--	2,037	105,483
1975	3,931	11,780	23,392	29,850	11,749	(8)	--	--	1,629	82,331

r Revised.
[1] Includes crucible furnace, 1958–67, and vacuum-melting furnace, 1963–67.
[2] Includes Brackelsberg furnace, 1937–51.
[3] Includes basic oxygen furnace, 1954–58.
[4] Not surveyed before 1942. Separately recorded, 1942–67, and included with other, 1968–75.
[5] Includes rerolling material and miscellaneous uses, 1942–67; includes vacuum-melting furnace and miscellaneous uses, 1968–75.
[6] Data may not add to totals shown because of independent rounding.
[7] Included with Bessemer.
[8] Included with other.
[9] Augmented reporting panel used beginning in 1974.

Table 12.—U.S. consumption of pig iron by type of furnace and for all other uses, 1935–1975

(Thousand short tons)

Year	Open hearth	Basic oxygen	Electric [1]	Cupola	Air [2]	Bessemer [3]	Direct casting	Other	Total [4]
1935	16,324	--	37	2,997	330	3,261	129	[5] 16	23,095
1936	24,596	--	26	4,070	456	4,072	457	[5] 34	33,710
1937	28,132	--	50	4,699	498	4,131	598	[5] 35	38,143
1938	15,377	--	18	2,693	208	2,180	243	[5] 6	20,725
1939	26,826	--	31	3,349	329	3,603	1,066	[5] 28	35,233
1940	36,297	--	47	4,106	374	3,829	1,504	[5] 28	46,186
1941	42,481	--	73	5,389	605	5,993	1,590	[5] 54	56,185
1942	45,539	--	93	4,491	555	6,131	2,184	[5] 50	59,043
1943	47,108	--	394	3,603	538	6,258	2,376	[5] 39	60,315
1944	48,281	--	240	3,941	499	5,583	2,377	[5] 29	60,952
1945	41,683	--	163	4,084	434	4,751	2,049	[5] 23	53,187
1946	34,608	--	113	4,613	356	3,723	1,642	[5] 17	45,072
1947	45,338	--	127	5,439	414	4,712	2,242	[5] 19	58,291
1948	47,267	--	132	5,281	368	4,778	2,184	[5] 16	60,026
1949	41,783	--	108	4,764	274	4,612	1,902	[5] 5	53,447
1950	50,946	--	154	6,059	335	5,170	2,275	[5] 4	64,943
1951	56,055	--	144	6,560	400	5,551	2,704	([6])	71,414
1952	49,374	--	119	5,438	318	3,999	2,303	([6])	61,551
1953	61,307	--	181	5,550	313	4,351	3,006	([6])	74,708
1954	48,632	([7])	178	4,897	232	2,849	1,874	([6])	58,662
1955	63,750	([7])	274	5,962	295	3,933	3,002	([6])	77,216
1956	62,166	([7])	233	5,349	293	4,039	2,916	([6])	74,995
1957	64,998	([7])	275	4,660	245	3,495	2,681	([6])	76,353
1958	48,408	([7])	256	3,709	190	2,636	2,064	--	57,262
1959	51,250	1,574	391	4,412	251	1,483	2,411	--	61,773
1960	55,270	2,937	372	3,822	210	1,303	2,712	--	66,626
1961	54,611	3,552	279	3,439	178	976	2,763	--	65,797
1962	54,509	5,020	240	3,402	186	792	2,446	--	66,595
1963	57,291	7,082	212	3,597	178	1,603	2,726	--	72,689
1964	65,206	12,446	325	3,704	170	949	3,582	--	86,382
1965	61,483	18,519	387	3,757	173	652	3,975	--	88,945
1966	55,508	27,821	286	3,667	167	332	3,989	--	91,770
1967	46,386	33,553	378	3,162	147	87	3,658	--	87,371
1968	r 40,229	r 40,951	519	2,909	([8])	([8])	([8])	[9] r 5,345	89,953
1969	r 37,976	r 48,610	332	2,911	92	--	([8])	[9] r 4,714	94,635
1970	r 32,204	r 51,730	453	2,076	94	--	([8])	[9] r 4,167	r 90,724
1971	23,573	52,023	825	1,865	60	--	([8])	[9] 2,869	81,215
1972	r 22,765	r 59,538	r 940	r 2,684	139	--	([8])	[9] r 3,074	89,140
1973	25,477	68,027	1,379	2,276	57	--	([8])	[9] r 2,605	r 99,821
1974 [10]	22,507	66,614	1,220	2,123	([8])	--	3,696	632	96,792
1975	14,554	59,210	1,019	1,362	([8])	--	3,010	483	79,638

r Revised.
[1] Includes crucible furnace, 1958–67, and vacuum melting furnace, 1963–67.
[2] Includes Brackelsberg furnace, 1937–51.
[3] Includes basic oxygen furnace, 1954–58.
[4] Data may not add to totals shown because of independent rounding.
[5] Includes crucible and puddling furnaces.
[6] Less than ½ unit.
[7] Included with Bessemer.
[8] Included with other.
[9] Includes pig iron used for direct casting.
[10] Augmented reporting panel used beginning in 1974.

Table 13.—U.S. exports and imports of iron and steel scrap, 1935–75
(Thousand short tons)

Year	Exports				Imports
	Iron and steel scrap [1] (includes tinplate scrap)	Rerolling material [2]	Ships, boats and other vessels for scrapping [3]	Total [4]	Iron and steel scrap (includes tinplate scrap)
1935	2,356	--	--	2,356	NA
1936	2,168	--	--	2,168	NA
1937	4,594	--	--	4,594	103
1938	3,358	--	--	3,358	42
1939	4,015	--	--	4,015	47
1940	3,159	--	--	3,159	21
1941	904	--	--	904	97
1942	142	--	--	142	126
1943	55	--	--	55	165
1944	96	--	--	96	131
1945	82	--	--	82	67
1946	142	--	--	142	58
1947	170	--	--	170	71
1948	212	--	--	212	481
1949	297	1	--	299	1,151
1950	217	--	--	217	785
1951	236	10	--	245	417
1952	351	1	--	353	154
1953	310	7	--	317	174
1954	1,679	17	--	1,696	239
1955	5,130	42	--	5,172	229
1956	6,340	106	--	6,446	256
1957	6,676	90	--	6,766	239
1958	2,883	45	--	2,928	333
1959	4,897	42	--	4,939	309
1960	7,055	126	--	7,181	179
1961	9,436	278	--	9,714	268
1962	5,014	98	--	5,112	210
1963	6,217	146	--	6,364	217
1964	7,766	132	--	7,898	282
1965	6,170	([5])	79	6,249	212
1966	5,750	107	23	5,881	407
1967	7,473	162	34	7,669	230
1968	6,444	127	120	6,691	294
1969	8,923	254	114	9,291	335
1970	10,111	251	531	10,893	301
1971	6,082	175	396	6,653	283
1972	7,177	207	299	7,683	312
1973	10,874	382	156	11,412	349
1974	8,497	199	327	9,023	201
1975	9,442	160	40	9,642	305

NA Not available.
[1] Excludes waste-waste tinplate after 1944 and circles, cobbles, strip and scroll shear butts after 1957.
[2] Not separately classified and not included as scrap before 1949.
[3] Not separately classified and not included as scrap before 1965.
[4] Data may not add to totals shown because of independent rounding.
[5] Included with iron and steel scrap.

Table 14.—U.S. exports and imports for consumption of iron and steel scrap, by class
(Thousand short tons and thousand dollars)

Class	1971		1972		1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Exports:										
No. 1 heavy melting scrap	1,827	64,514	2,289	79,246	3,780	207,743	2,565	262,810	2,766	233,784
No. 2 heavy melting scrap	645	20,297	756	23,200	1,107	52,817	883	84,826	1,102	85,508
No. 1 bundles	233	8,460	180	6,112	391	21,565	78	8,504	120	9,574
No. 2 bundles	987	22,519	897	19,623	1,221	49,421	1,304	99,652	1,159	71,903
Stainless steel scrap	44	12,518	48	11,679	49	16,731	35	15,351	66	27,463
Shredded steel scrap	1,026	36,568	1,463	48,186	2,098	118,133	1,999	225,990	2,406	206,691
Borings, shovelings, and turnings	390	8,663	508	10,761	521	16,352	544	35,404	597	29,721
Other steel scrap [1]	465	19,030	597	21,562	1,102	57,528	463	40,814	726	63,565
Iron scrap	465	13,851	439	13,026	605	29,721	626	50,369	500	34,767
Total	6,082	206,420	7,177	233,395	10,874	570,011	8,497	823,720	9,442	762,976
Ships, boats and other vessels (for scrapping)	396	6,824	299	9,009	156	8,056	327	33,140	40	1,742
Rerolling material	175	8,978	207	10,213	382	28,489	199	25,025	160	16,266
Grand total	6,653	222,222	7,683	252,617	11,412	606,556	9,023	881,885	9,642	780,984
Imports:										
Iron and steel scrap	263	10,713	295	14,304	337	18,716	188	26,166	293	24,464
Tinplate scrap	20	546	17	437	12	384	13	861	12	786
Total	283	11,259	312	14,741	349	19,100	201	27,027	305	25,250

[1] Includes terneplate and tinplate.

Table 15.—U.S. exports of iron and steel scrap, by country
(Thousand short tons and thousand dollars)

Country	1971		1972		1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	63	1,757	231	7,857	261	13,840	148	16,189	332	29,110
Belgium-Luxembourg	8	947	5	300	3	535	(1)	105	16	1,813
Brazil	1	15	61	2,174	5	229	27	3,321	7	1,025
Canada	887	26,204	903	26,605	811	27,097	940	52,296	873	44,676
Chile	3	305	5	417	15	1,255	23	2,828	(1)	2
China, People's Republic of	--	--	--	--	428	23,729	189	12,406	175	13,243
Egypt	--	--	--	--	--	--	15	1,611	34	2,660
France	8	298	(1)	5	30	2,682	16	4,019	7	1,325
Germany, West	13	1,152	7	473	2	283	4	1,481	14	6,027
Greece	37	1,228	163	4,893	187	9,429	113	12,762	161	12,964
Hong Kong	26	1,023	1	277	1	231	1	83	1	207
Israel	--	--	--	--	(1)	6	27	2,857	15	1,134
Italy	590	22,599	717	23,222	353	23,966	485	58,896	613	57,548
Japan	1,744	54,369	2,309	71,309	4,666	234,363	2,980	305,223	2,405	198,884
Korea, Republic of	324	11,799	380	13,086	739	42,429	680	76,754	762	61,842
Mexico	555	20,027	587	22,301	1,009	56,063	890	72,432	1,269	103,208
New Zealand	--	--	19	535	42	2,479	17	2,189	18	1,599
Pakistan	52	1,639	[2]21	[2]766	1	96	[2]48	[2]6,206	[2]87	[2]6,951
Peru	--	--	6	443	--	--	23	3,103	93	7,767
Philippines	20	569	14	312	--	--	17	2,167	67	6,225
Singapore	--	--	25	971	15	1,179	--	--	81	5,761
Spain	610	20,354	721	21,452	1,127	58,197	896	89,696	1,709	131,600
Sweden	20	4,437	21	4,545	8	2,171	33	5,138	95	11,266
Taiwan	387	12,584	419	14,028	672	39,527	491	44,454	264	24,168
Thailand	39	1,464	85	2,945	139	8,408	34	3,311	37	3,076
Turkey	73	2,465	125	4,571	124	7,212	57	6,323	89	6,645
United Kingdom	335	12,785	25	1,029	142	9,203	117	14,442	78	9,373
Venezuela	212	5,244	284	7,734	76	3,802	183	17,679	72	4,626
Yugoslavia	56	2,271	--	--	--	--	--	--	37	3,258
Other	19	885	43	1,145	18	1,600	43	5,749	31	4,993
Total	6,082	206,420	7,177	233,395	10,874	570,011	8,497	823,720	9,442	762,976

[1] Less than ½ unit.
[2] Includes Bangladesh: 1972—14,781 short tons ($521,810); 1974—(revised) 15,853 short tons ($1,951,756); 1975—56,862 short tons ($4,420,254).

Table 16.—U.S. exports of rerolling material (scrap), by country

(Thousand short tons and thousand dollars)

Country	1971		1972		1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	--	--	--	--	--	--	--	--	12	1,055
Canada	1	46	2	118	1	34	7	485	5	408
China, People's Republic of	--	--	--	--	7	485	1	85	--	--
Italy	1	44	--	--	2	168	--	--	--	--
Japan	5	190	17	789	16	1,209	1	182	--	--
Korea, Republic of	83	4,562	73	3,491	118	7,014	81	10,504	29	3,189
Mexico	27	1,530	35	1,883	43	2,954	47	5,269	40	4,623
Pakistan	--	--	24	1,047	8	422	4	617	4	402
Spain	1	59	5	319	(1)	7	--	--	17	1,336
Taiwan	44	2,023	20	951	149	12,712	57	7,712	39	3,478
Thailand	--	--	15	654	28	2,641	--	--	13	1,518
Turkey	--	--	9	533	4	292	(1)	40	(1)	61
Venezuela	2	105	3	200	3	210	--	--	--	--
Yugoslavia	11	419	--	--	--	--	--	--	--	--
Other	--	--	4	228	3	341	1	131	1	196
Total	175	8,978	207	10,213	382	28,489	199	25,025	160	16,266

[1] Less than ½ unit.

Table 17.—U.S. exports of ships, boats, and other vessels for scrapping

(Thousand short tons and thousand dollars)

Country	1971		1972		1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Canada	30	493	36	583	2	260	26	1,414	15	406
Germany, West	5	77	--	--	8	257	13	700	(1)	(1)
Japan	--	--	5	74	--	--	--	--	--	--
Korea, Republic of	--	--	--	--	9	370	44	5,826	7	237
Mexico	--	--	--	--	1	132	(1)	23	--	--
Netherlands	--	--	--	--	(1)	40	--	--	(1)	1
Spain	255	4,788	146	3,907	22	1,002	93	8,824	10	426
Taiwan	106	1,463	112	4,445	114	5,994	139	15,539	8	617
Other	(1)	3	--	--	(1)	1	12	814	(1)	55
Total	396	6,824	299	9,009	156	8,056	327	33,140	40	1,742

[1] Less than ½ unit.

Table 18.—U.S. imports for consumption of iron and steel scrap, by country

Country	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Australia	114	$55	27	$15
Bahamas	178	33	7,308	200
Belgium-Luxembourg	119	7	87	52
Canada	195,363	25,005	235,263	18,935
Chile	196	10	--	--
Costa Rica	85	8	--	--
Dominican Republic	671	46	961	70
Finland	81	116	--	--
Germany, West	72	25	132	71
Haiti	155	6	528	11
Hong Kong	124	67	82	43
Jamaica	1,530	80	2,197	110
Japan	30	28	56,438	5,233
Leeward and Windward Islands	105	25	50	5
Liberia	28	1	--	--
Mexico	979	92	963	158
Netherlands	255	584	24	11
Nicaragua	--	--	141	25
Sweden	--	--	9	7
Taiwan	110	19	378	63
Trinidad and Tobago	178	7	254	9
United Kingdom	611	788	397	215
Other	141	25	120	17
Total	201,125	27,027	305,359	25,250

Table 19.—Iron and steel scrap consumption in selected countries [1]

(Thousand short tons)

	1971	1972	1973	1974	1975
European Economic Community:					
Belgium [2]	3,822	4,806	5,060	5,429	4,091
Denmark [2]	573	558	463	577	634
France [3 4 5]	8,960	9,436	9,913	10,340	8,307
Germany, West [4]	23,343	25,137	27,540	28,195	22,495
Ireland	e 80	e 95	121	121	e 90
Italy [3]	12,317	13,644	14,592	16,215	15,047
Luxembourg	1,703	1,801	1,954	2,098	1,513
Netherlands	2,456	2,471	2,249	2,342	1,744
United Kingdom [2 5]	19,708	20,603	e 20,500	18,690	17,526
Total [6]	72,962	78,551	82,392	84,007	71,447
European Free Trade Association:					
Austria [3 5]	1,739	1,736	1,747	1,904	1,625
Norway [2 4 5]	[3]534	[3]540	[3]560	616	618
Portugal [2 3 4 5]	184	e 190	e 200	e 150	e 190
Sweden [2 3]	3,488	3,621	[7]3,954	4,119	e 3,690
Total [6]	5,945	6,087	6,461	6,789	6,123
Other European market economy countries: [8]					
Finland	646	790	818	782	767
Spain	e [5]5,840	[5]6,446	[5]7,185	8,229	e 7,390
Yugoslavia [8]	1,781	1,692	1,906	e 2,090	e 2,200
Total [6]	8,267	8,928	9,909	11,101	10,357
European centrally planned economy countries: [8]					
Czechoslovakia [2 4 5]	[3]4,998	[3]6,593	6,165	7,626	7,886
Germany, East [2 3 4 5]	e 4,740	e 4,810	e 4,820	4,836	4,852
Hungary [2 4 5]	2,135	2,262	2,253	2,288	2,392
Poland [2 4 5]	e 7,610	8,067	8,667	9,080	e 9,370
Romania [2 4 5 9]	3,301	3,120	e 3,090	e 3,310	e 3,530
U.S.S.R. [2 3 4 5 10]	[11]48,336	49,546	50,990	51,656	51,806
Total [6]	71,120	74,398	75,985	78,796	79,836

See footnotes at end of table.

Table 19.—Iron and steel scrap consumption in selected countries [1]—Continued
(Thousand short tons)

	1971	1972	1973	1974	1975
Latin America:[12]					
Argentina [5]	[e] 1,630	[e] 1,830	1,878	1,953	1,758
Brazil [5]	[e] 3,060	[e] 3,330	3,653	3,771	4,040
Chile [5]	[e] 240	[e] 180	200	250	185
Colombia [5]	[e] 170	[e] 200	191	185	248
Mexico [5]	[e] 2,470	[e] 2,850	3,069	2,982	3,663
Peru [5]	[e] 75	[e] 80	150	174	192
Venezuela [5]	[e] 550	[e] 670	632	626	581
Other [5 13]	[e] 13	[e] 13	12	24	44
Total [6]	[e] 8,208	[e] 9,153	9,785	9,965	10,711
Other countries:					
Canada [2 3 4 5]	5,776	6,048	7,631	7,842	7,444
India [2 3 4 5]	[14] 1,759	[14] 1,624	[14] 1,744	[e] 1,790	[e] 1,980
Japan [5]	36,824	43,726	53,628	50,867	37,714
South Africa, Republic of [2 3 4 5]	[15] 2,398	[15] 2,212	[15] 2,593	[e] 2,690	[e] 2,980
Turkey [2 5]	[e] 355	[e] 500	[e] 285	702	[e] 510
United States [2]	82,567	95,259	103,590	105,483	82,331
Total [6]	129,679	149,369	169,471	169,374	132,959
Grand total [6]	296,181	326,486	354,003	360,032	311,433

[e] Estimate.
[1] Unless otherwise noted, figures represent consumption of scrap in the production of pig iron, ferroalloys, crude steel, foundry products, and rerolled steel, as well as in other unspecified uses by the steel industry and by other (unspecified) industries. Also, unless otherwise noted, figures are from: United Nations Economic Commission for Europe, Annual Bulletin of Steel Statistics for Europe. V. III, 1975. New York, 1976, 97 pp.
[2] Excludes scrap consumed in rerolling.
[3] Excludes scrap consumed in foundries.
[4] Excludes scrap consumed within the steel industry for purposes other than manufacture of pig iron, ferroalloys, crude steel, and foundry products and that used in rerolling.
[5] Excludes scrap used outside the steel industry.
[6] Total of listed figures.
[7] Central Statistics Bureau. Bergshantering (Mining) 1973. Stockholm 1974, p. 105.
[8] Following United Nations' practice, Yugoslavia has been included with other market economy nations of Western Europe.
[9] Excludes scrap used in production of pig iron.
[10] Excludes scrap used in production of steel by any method of production except open hearth furnace.
[11] British Steel Corporation. International Steel Statistics, the U.S.S.R., 1973, p. 2.
[12] 1971-72: U.S. Bureau of Mines estimates; 1973-74: Latin American Iron and Steel Institute. Anuario Estadistico de la Siderurgia y Mineria del Fierro de America Latina 1974, p. 18, Santiago (undated); 1975: Latin American Iron and Steel Institute. Informativo Estadistico No. 29, Sept. 16, 1976 (not paginated). Data for 1973-74 are given in sources as total consumption by the steel industry, but no breakdown by use within that industry is provided, and sources do not make it clear whether or not consumption in foundries and rerolling plants is included; consumption other than in the steel industry is clearly excluded.
[13] Uruguay plus unspecified countries in Central America, as reported in source.
[14] British Steel Corporation. International Steel Statistics, India 1973, p. 2.
[15] British Steel Corporation. International Steel Statistics, the Republic of South Africa, 1973, p. 2.

Table 20.—Iron and steel scrap exports by selected countries [1]
(Thousand short tons)

	1971	1972	1973	1974	1975
European Economic Community:					
Belgium-Luxembourg	505	434	614	800	586
Denmark	40	97	123	143	100
France	3,021	3,395	3,073	4,107	3,097
Germany, West	2,409	2,339	2,541	2,806	2,431
Ireland	10	14	14	13	[2] 8
Italy	10	17	11	12	[2] 6
Netherlands	617	734	961	1,293	1,032
United Kingdom	1,130	1,203	817	348	1,010
Total [3]	7,742	8,233	8,154	9,517	8,270
European Free Trade Association:					
Austria	4	14	8	13	22
Norway	20	18	28	37	21
Portugal	6	19	55	2	2
Sweden	14	13	13	12	12
Switzerland	33	101	120	129	129
Total [3]	77	165	224	193	186
Other European market economy countries: [4]					
Finland	3	12	8	10	6
Greece	16	57	47	107	64
Iceland	1	3	6	10	3
Spain	([5])	1	3	2	[2] 1
Yugoslavia [4]	25	20	24	26	[2] 14
Total [3]	45	93	88	155	88
European centrally planned economy countries: [4]					
Bulgaria	[6] 3	[6] 37	78	118	134
Czechoslovakia	[6] 257	[6] 325	[6] 236	[e] 240	[e] 220
Germany, East	22	82	36	29	1
Hungary	29	143	188	130	34
Poland	176	464	560	496	313
U.S.S.R	1,905	1,764	2,030	1,615	1,256
Total [3]	2,392	2,815	3,128	2,628	1,958
Latin America:					
Mexico	[7] 9	[7] 8	[7] 4	--	NA
Other	[7] 6	[7] 13	[e] 17	[e] 13	[e] 11
Total [3]	15	21	21	[e] 13	[e] 11
Other countries:					
Australia	542	448	722	974	637
Canada	459	481	702	292	463
India	[2] 161	[2] 86	[2] 123	[2] 115	[e] 90
Japan	423	245	229	332	105
Korea, Republic of (South) [7]	2	2	2	1	([5])
Morocco	[7] 34	[7] 35	[7] 1	[7] 88	[e] 45
New Zealand	[7] 7	[7] 3	[7] 4	[7] 2	[e] 2
Singapore	[7] 1	[7] 4	[7] 1	[7] 2	[e] 2
South Africa, Republic of	[7] 7	[7] 6	[8] 1	NA	NA
Taiwan [7]	13	66	9	47	35
Turkey	--	NA	--	([5])	--
United States	6,257	7,382	11,257	8,686	9,609
Total [3]	7,906	8,758	13,051	10,539	10,988
Grand total [3]	18,177	20,085	24,666	23,045	21,501

[e] Estimate. NA Not available.
[1] Unless otherwise noted, United Nations Economic Commission for Europe. Annual Bulletin of Steel Statistics for Europe. V. III, 1975. New York, 1976, 97 pp.
[2] Statistisches Bundesamt. Eisen und Stahl, 3rd quarter 1976. Dusseldorf, 1976, 143 pp.
[3] Total of listed figures.
[4] Following United Nations' practice, Yugoslavia has been included with other market economy nations of Western Europe.
[5] Less than ½ unit.
[6] Partial figure; compiled from import statistics of selected trading partner countries.
[7] Official trade returns of subject countries.
[8] British Steel Corporation. International Steel Statistics, the Republic of South Africa, 1973, p. 6.

Table 21.—Iron and steel scrap imports by selected countries [1]

(Thousand short tons)

	1971	1972	1973	1974	1975
European Economic Community:					
Belgium-Luxembourg	694	911	765	958	779
Denmark	2	--	4	4	3
France	277	249	481	362	305
Germany, West	1,151	1,332	1,631	1,996	1,895
Ireland	1	13	49	28	[2]4
Italy	6,040	6,260	6,177	6,917	[2]5,957
Netherlands	104	110	111	96	176
United Kingdom	326	44	245	154	97
Total [3]	8,595	8,919	9,463	10,515	9,216
European Free Trade Association:					
Austria	91	57	110	97	2
Norway	56	66	30	56	60
Portugal	11	26	7	9	7
Sweden	203	218	306	406	373
Switzerland	30	86	69	121	107
Total [3]	391	453	522	689	549
Other European market economy countries: [4]					
Finland	201	74	68	93	105
Greece	17	106	164	26	108
Spain	1,523	2,012	2,218	2,122	[2]866
Yugoslavia [4]	277	298	330	461	[2]138
Total [3]	2,018	2,490	2,780	2,702	1,217
European centrally planned economy countries: [4]					
Bulgaria	NA	[5]6	--	--	--
Czechoslovakia	[5]4	[5]2	[5]9	[5]13	NA
Germany, East	279	216	367	437	384
Hungary	2	([6])	2	2	1
Poland	7	--	([6])	3	2
Total [3]	292	224	378	455	387
Latin America:					
Argentina	[7]63	NA	([6 7])	1	NA
Brazil	([6 7])	[7]35	[7]1	[7]6	[e]5
Chile	[7]7	[7]11	[7]15	[7]12	[e]10
Cuba	--	[5]57	[5]62	[7]65	[5]61
Mexico	[7]563	[7]581	[7]1,066	[7]874	[e]1,400
Peru	--	13	NA	NA	NA
Venezuela	[7]223	[7]322	[7]77	[7]182	[e]220
Other [e]	2	3	4	4	3
Total [3]	858	1,022	1,225	1,144	1,699
Other countries:					
Canada	1,187	1,225	1,008	848	1,024
China, People's Republic of [5]	301	180	571	188	219
Egypt	[7]69	[7]73	[7]49	NA	NA
India	20	9	28	11	[e]10
Iran	[7]9	[7]14	[7]17	[7]7	[e]10
Japan	2,813	2,755	5,962	3,923	3,409
Korea, Republic of (South) [7]	832	573	888	1,235	930
Philippines	[7]7	[7]50	[7]4	[7]19	NA
Singapore	[7]65	[7]117	[7]68	[7]29	[e]55
South Africa, Republic of	[7]32	[7]55	[8]21	NA	NA
Taiwan [7]	558	665	789	866	389
Thailand [7]	222	310	403	282	294
Turkey	114	120	206	[7]130	[7]94
United States	283	312	348	201	305
Total [3]	6,512	6,458	10,362	7,739	6,739
Grand total [3]	18,666	19,566	24,730	23,244	19,807

[e] Estimate. NA Not available.

[1] Unless otherwise noted, United Nations Economic Commission for Europe. Annual Bulletin of Steel Statistics for Europe. V. III, 1975. New York, 1976, 97 pp. It should be noted that among major steel producing nations, the U.S.S.R. and Romania do not import any substantial quantity of scrap.

[2] Statistisches Bundesamt. Eisen und Stahl, 3rd quarter 1976. Dusseldorf, 1976, 143 pp.

[3] Total of listed figures.

[4] Following United Nations' practice, Yugoslavia has been included with other market economy nations of Western Europe.

[5] Partial figure; compiled from export statistics of trading partner countries.

[6] Less than ½ unit.

[7] Official trade returns of subject country.

[8] British Steel Corporation. International Steel Statistics, the Republic of South Africa, 1973, p. 6.

Kyanite and Related Materials

By Michael J. Potter [1]

Kyanite, andalusite, and sillimanite are anhydrous aluminum silicate minerals that are alike in both composition and use patterns and have the same chemical formula, $Al_2O_3 \cdot SiO_2$. Related materials include synthetic mullite, dumortierite, and topaz, also classified as aluminum silicates, although the last two additionally contain substantial proportions of boron and fluorine, respectively. All of these kyanite-group substances have the capability of serving as raw materials for manufacturing special high-performance refactories in the high-alumina category, but there has been no record in recent years of significant utilization of either dumortierite or topaz for this purpose in the United States.

Although published statistics are not sufficiently complete to be wholly conclusive, it appears that the United States, India, and the Republic of South Africa are the leading world producers of kyanite-group minerals. It can be presumed that the U.S.S.R. and perhaps a few other industrialized nations also produce significant quantities of these materials.

Domestic kyanite production in 1975 was somewhat lower in tonnage and value compared with 1974. U.S. exports of kyanite and related minerals have shown an increasing trend over the last several years, including 1975. U.S. imports, however, have decreased from 7,600 tons in 1955 to 65 tons in 1975.

Activities of U.S. companies included the C-E Minerals, Inc. plant expansion at Graves Mountain, Ga., and Kyanite Mining Corp.'s construction work on its third concentrating plant near Willis Mountain, Va. Ethyl Corp. continued its development program at Woodrat Mountain, Idaho.

Legislation and Government Programs.—The allowable depletion rates for kyanite, established by the Tax Reform Act of 1969 and unchanged through 1975, were 22% for domestic production and 14% for foreign operations.

The U.S. Geological Survey's Office of Minerals Exploration provides government loans of up to 50% of approved costs for the exploration of eligible kyanite deposits; no loans for that purpose were made in 1975.

DOMESTIC PRODUCTION

Kyanite was produced in 1975 at three open pit mines: Two in Virginia and one in Georgia. Kyanite Mining Corp. operated the Willis Mountain mine in Buckingham County, Va., and the Baker Mountain mine in adjoining Prince Edward County, Va. C-E Minerals, Inc., operated the Graves Mountain mine in Lincoln County, Ga.

Domestic kyanite output in 1975, as measured by the quantity sold or used, was somewhat lower in tonnage and value than in 1974. Specific kyanite production statistics for 1975 (as well as for all years since 1949) are withheld to avoid disclosure of individual company confidential data.

Synthetic mullite production showed a noticeable drop, both in tonnage and value, compared with 1974. Output in 1975, coming from five companies, was largely high-temperature sintered material. Producers were A.P. Green Refractories Co. at Philadelphia, Pa.; C-E Minerals, Inc. at Americus, Ga.; Harbison-Walker Refractories at Eufala, Ala.; and Taylor Refractories Division, NL Industries, Inc. at Greenup, Ky. Electric-furnace fused mullite was produced by the Carborundum Co. at Niagara Falls, N.Y.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Synthetic mullite production in the United States

Year	Quantity (short tons)	Value (thousands)
1971	55,077	$4,945
1972	46,389	4,080
1973	58,176	5,211
1974 [r]	41,508	5,895
1975	24,147	3,350

[r] Revised.

CONSUMPTION AND USES

Kyanite and related materials, conforming to the established end use pattern, were consumed in 1975 mostly in the manufacture of high-alumina or mullite-class refractories and in lesser quantities as ingredients in some ceramic compositions. Imported Indian kyanite was calcined in its natural lump form, after which it was usually separated into designated particle-size ranges for use chiefly as a grog. Domestic kyanite, already ground to minus 35-mesh as required by the flotation process used in its separation and recovery, was marketed in the raw form or after heat treatment; that is, as mullite, which was sometimes further reduced in particle size before use. In the 35- to 48-mesh range, the mineral was used mostly in monolithic refractory applications such as for high-temperature mortars or cements, ramming mixes, and castable refractories, or with clays and other ingredients in refractory compositions for making kiln furniture, insulating brick, firebrick, and a wide variety of other refractory articles. More finely ground material, minus 200-mesh for example, was used in body mixes for sanitary porcelains, wall tile, precision casting molds, and miscellaneous special-purpose ceramics.

PRICES

Engineering and Mining Journal, December 1975, listed prices for kyanite, f.o.b. Georgia, ranging from $63 to $118 per short ton for bulk shipments and $9 more per ton for bagged material.

Price ranges quoted for kyanite-group materials in Ceramic Industry Magazine, January 1976, were as follows:

	Per short ton
Andalusite	$30–$60
Kyanite	63–116
Mullite, calcined	275–285
Mullite, fused	160–450

The December 1975 issue of Industrial Minerals (London) quoted kyanite-group price ranges approximately equivalent (with some uncertainty due to a floating exchange rate) to the following:

	Per short ton
Andalusite, Transvaal, c.i.f. main European port	$82
Kyanite, Indian, f.o.b	92
Sillimanite, Indian, natural bagged, f.o.b	73 nominal
Kyanite, Indian, calcined. f.o.b. Calcutta	$174–183

FOREIGN TRADE

U.S. exports of kyanite and related minerals in 1975 showed an increase compared with 1974, while imports decreased. From 1955 to 1975, U.S. imports of kyanite minerals have diminished from 7,600 tons to 65 tons. It can be supposed that the greater part of the material currently being exported consists of mullite. It should be noted, however, that some element of uncertainty is inherent in such conclusions because the Bureau of the Census export figures, on which they are based, do not clearly distinguish synthetic mullite from some other mullite-containing materials prepared by high-temperature processing of certain bauxitic and kaolinitic minerals.

Table 2.—U.S. exports and imports for consumption of kyanite and related minerals

	1973		1974		1975	
	Quantity (short tons)	Value	Quantity (short tons)	Value	Quantity (short tons)	Value
Exports:						
Argentina	257	$21,279	110	$14,028	160	$14,926
Australia	7,145	266,817	12,578	656,843	9,918	615,663
Belgium-Luxembourg	1,452	276,476	1,305	97,557	221	58,062
Brazil	3,965	181,819	2,465	217,703	582	29,700
Canada	6,010	423,327	6,843	468,929	5,175	361,361
Colombia	89	5,547	210	14,656	301	20,869
Denmark	912	62,664	--	--	134	11,919
France	803	102,263	286	57,057	600	69,973
Germany, West	49,081	2,489,435	54,090	2,908,878	65,487	3,582,084
Guatemala	--	--	125	8,428	--	--
Hong Kong	--	--	5	809	48	7,262
Israel	8	518	--	--	200	11,255
Italy	4,859	372,819	12,085	970,953	13,066	921,974
Japan	2,783	220,297	16,483	988,077	30,666	1,796,826
Mexico	2,731	192,239	4,776	366,032	3,045	318,374
Netherlands	6,449	405,806	12,159	606,341	1,120	84,598
New Zealand	369	34,697	40	3,519	20	1,690
Philippines	271	32,117	151	17,726	12	2,205
South Africa, Republic of	3,909	251,574	32	5,573	3	1,168
Spain	--	--	4,289	202,804	--	--
Sweden	811	56,761	5,365	335,787	5,755	385,925
Switzerland	--	--	84	6,851	--	--
Taiwan	--	--	66	1,896	49	3,542
U.S.S.R	--	--	--	--	1,734	170,182
United Kingdom	826	64,088	1,746	185,058	11,110	739,346
Venezuela	949	86,080	622	65,183	850	137,230
Other	35	5,270	67	4,286	113	9,277
Total	93,714	5,551,893	135,982	8,204,974	150,369	9,355,411
Imports:						
France	2	926	--	--	--	--
India	177	9,080	110	4,939	65	2,849
Mexico	--	--	17	2,005	--	--
Netherlands	--	--	11	620	--	--
South Africa, Republic of	42	3,218	56	4,848	--	--
Total	221	13,224	194	12,412	65	2,849

WORLD REVIEW

Complete statistical information is not available on foreign production of kyanite-group minerals and materials. Although official data are not available, it was estimated that in excess of 77,000 tons of kyanite and related minerals was produced in the U.S.S.R. in 1974. Interest was being maintained in potential kyanite deposits in Austria, Botswana, Canada, Kenya, Liberia, Malawi, Norway, Scotland, the Republic of South Africa and Tanzania.[2]

Brazil.—Plans were made to build a mine-mill facility in Minas Gerais State to produce refractory-grade kyanite. The company, Mineração Interex do Brasil Ltda., is a joint venture between Adela Empreendimentos of São Paulo and Nord Resources of Albuquerque, N. Mex. The project will require an estimated $800,000 to construct a 16,500-ton-per-year kyanite plant, with the new facility scheduled to be onstream in mid-1976.[3]

France.—Denain-Anzin Minéraux reported andalusite production of slightly under 11,000 tons in 1974 from their Glomel deposit in Brittany. Recently installed facilities are producing ground material in different mesh sizes. New capacity was to be put into operation by the end of 1975, bringing output capability of Glomel to 44,000 tons per year.[4]

Germany, West.—Imports of kyanite-group minerals amounted to 21,035 tons in 1973. The principal countries of origin and the percent supplied were the Republic of South Africa 41%, India 24%, the United Kingdom 17%, and France 8%. In 1974, kyanite-group imports were 26,870 tons. The principal suppliers and the share provided were the Republic of

[2] Black, C.D.G. Sillimanite Minerals. Mining Annual Review (London), June 1975, p. 128.
[3] Engineering and Mining Journal. V. 176, No. 10, October 1975, p. 159.
[4] Work cited in footnote 2.

South Africa 35%, India 23%, the United Kingdom 17%, and France 12%.[5]

India.—Indian production of kyanite is derived from three localities. The Lapsa Buru deposit contains a high quality kyanite. The Geological Survey of India has estimated kyanite reserves of 60% to 62% Al_2O_3 at 4.2 million tons. Apart from this are 74.3 million tons of 30% kyanite-quartz rock in the Singhbhum district, the potential of which has yet to be evaluated.[6]

Production of sillimanite has been in the range of 3,500 to 4,500 tons per year, and reserves, estimated at 500,000 tons, are ample. To meet a domestic demand of 16,500 tons per year, however, production would have to be raised and additional resources assessed (for example, the sillimanite-quartz rock deposits in Karnataka).[7]

At yearend 1975, Rare Earth Ltd. was constructing a $2.9 million monazite sand separation plant on a 26-square-mile area in Gopalpur in Southern Orissa. Various minerals are to be produced, including an estimated initial annual output of 60,000 tons of sillimanite.[8]

At the end of 1973, the Geological Survey of India reported finding an andalusite deposit covering 6 square miles near Nagar Untari in Bihar. Reserves were tentatively estimated at 4 million tons of ore per yard depth.[9]

South Africa, Republic of.—The Republic of South Africa, the leading producer of sillimanite among market economy countries, has deposits of sillimanite-corundum rock occurring in schists and gneisses. The sillimanite-bearing schists have an alumina content of 55% to 60%, but the extremely hard sillimanite-corundum rock can be as high as 75% Al_2O_3. Production was down during the first half of 1974 compared with 1973, but exports were being maintained at the usual level of 7,500 tons during January-June 1974.

Large deposits of andalusite exist in the Transvaal. Production in the first half of 1974 was 36,000 tons, with about 20% being exported.[10]

Table 3.—Kyanite, sillimanite and related materials: World production, by country[1]
(Short tons)

Country and commodity[2]	1973	1974	1975 p
Australia: Sillimanite[3]	708	828	e 825
India:			
Kyanite	r 64,171	49,911	e 56,500
Sillimanite	r 3,459	3,215	e 9,300
Korea, Republic of: Andalusite	91	127	e 145
South Africa, Republic of:			
Andalusite	66,912	70,557	85,042
Sillimanite	21,293	14,426	18,641
Spain: Andalusite	6,173	8,059	e 8,000
United States:			
Kyanite	W	W	W
Synthetic mullite	58,176	41,508	24,147

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.
1 Owing to incomplete reporting, the table has not been totaled.
2 In addition to the countries listed, a number of other countries presumably produce kyanite and related minerals, but output data are not reported and no basis is available for estimates of output levels.
3 In addition, sillimanite clay (also called kaolinized sillimanite) is produced, but available information is inadequate to make reliable estimates.

TECHNOLOGY

Drilling programs on ore bodies immediately adjacent to their current mining operations were conducted by both major kyanite producers (C-E Minerals, Inc. and Kyanite Mining Corp.). This resulted in the further increase of their already large proven ore reserves. What reportedly could be the world's largest kyanite deposit was purchased by Kyanite Mining Corp. The Crocan Lake deposit, near North Bay, Ontario, is said to contain at least 50 million tons of ore occurring to an explored depth of 100 feet.

In 1975, the expansion of the C-E Min-

5 Industrial Minerals (London). West German Industrial Minerals Imports 1973–74. No. 93, June 1975, p. 54.
6 Pages 127–128 of work cited in footnote 2.
7 Work cited in footnote 2.
8 U.S. Embassy, New Delhi, India. Selected Science and Technology Items from the Indian Press, May–August 1975. State Department Airgram A-389, Dec. 17, 1975, p. 4.
9 Work cited in footnote 2.
10 Work cited in footnote 2.

erals' Graves Mountain plant increased the company's capacity to 70,000 tons per year. Construction continued on Kyanite Mining's third concentrating plant, at the East Ridge deposit, immediately east of Willis Mountain. This new plant is scheduled for completion by fall 1976, with a productive capacity of 100,000 tons per year.

In the Western United States, Ethyl Corp. continued its development program at Woodrat Mountain, Idaho. The company was reportedly looking for an electrolytic plant site with 400,000 kilowatts per year of guaranteed power to process the kyanite concentrates into a new product.[11]

Construction was underway in 1975 on a blast furnace, said to be the largest in the Western Hemisphere, at Bethlehem Steel Corp., Sparrow's Point, Md. Some use was made of mullite refractories in the stoves.[12]

For many practical applications of ceramic materials, it is desirable to know certain properties of these materials. In conjunction with this, a commercial mullite material was analyzed with respect to its composition, microstructure, and mechanical properties.[13]

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[11] Radcliffe, D. Industrial Mineral Commodities (Kyanite). Min. Eng., v. 28, No. 3, March 1976, p. 39.

[12] Brick & Clay Record. Yard Talk. V. 166, No. 4, April 1975, p. 55.

[13] Lewis, D. Mechanical Characterization of Commercial Ceramic Materials. Am. Ceram. Soc. Bull., v. 54, No. 3, March 1975, pp. 310–311.

Lead

By J. Patrick Ryan [1] and John M. Hague [1]

In 1975, world mine production of lead declined slightly from the 1974 level, but remained near the average of the last 5 years at about 3.80 million tons. Smelter production was 3.71 million tons, down about 4% from the peak output achieved in 1974. World metal consumption decreased about 10% and was moderately less than metal production; the excess production was balanced by a net buildup in producers' and other stocks. Only minimal sales were made from the U.S. Government stockpile during the year. World producers' stocks outside centrally planned economy countries increased from approximately 270,000 tons at the beginning of the year to 360,000 tons at the end of May, declined thereafter to 266,000 tons in October, and rose again to 296,000 tons at yearend. Consumer stocks declined during the year in the United States and the United Kingdom but increased in Japan. The U.S. producer price of lead remained at 24.50 cents per pound through the first quarter, virtually at parity with the London Metal Exchange (LME) price. It then dropped to 22.5 cents in May and to 19 cents in June, increased to 20 cents through November, and dropped to 19 cents in December. During the last 3 quarters, the U.S. producers price was 3 to 4 cents above the equivalent LME cash price, which was about 15.5 cents per pound at yearend.

Domestic mine production decreased 6% from the record high level of 1974 to 621,500 tons in 1975. Primary refinery output from domestic and foreign concentrates also declined about 7% to 638,250 tons. Secondary smelter output dropped to 658,500 tons, nearly 6% below the record output of 1974.

U.S. consumption of lead, reflecting the falloff in demand attributed to the general business recession, declined to 1.30 million tons, about 19% below the record high reported in 1974 and the lowest level of consumption since 1967. Most of the decline was in the transportation sector of the economy; batteries for the automotive industry and antiknock additives in gasoline, which together accounted for 70% of total lead consumption, were down 18% and 17%, respectively. Lead used in pigments, ammunition, and most other metal products was also substantially less than in 1974.

Stocks of refined and antimonial lead at primary plants increased 44,000 tons during the year to 81,300 tons at yearend. Consumers' stocks of refined soft lead and lead in antimonial lead and other alloys declined from 165,400 tons in January to 131,700 tons at yearend.

Legislation and Government Programs.—The General Services Administration (GSA) reported that commitments to purchase surplus lead from the Government stockpile fell sharply in 1975. Sales were suspended in the third quarter when stocks held by primary producers reached the cutoff level. The stockpile objective was unchanged at 65,100 tons. The uncommitted stockpile surplus at yearend was 536,519 tons, of which 71,621 tons was available for disposal under long-term contracts. Actual physical drawdown of government stocks during 1975 was about 7,000 tons, leaving a total inventory in storage of 601,670 tons on December 31.

The Environmental Protection Agency (EPA) under authority of the Federal Water Pollution Control Act, as amended, published proposed effluent limitations and guidelines for existing and new ore mining and dressing facilities to be achieved by

[1] Physical scientist, Division of Nonferrous Metals.

the application of best available technology. The quantity of pollutants discharged in mine drainage from lead-bearing ores and from mills employing the flotation process will be limited to a maximum for any 1 day of 0.4 milligrams per liter and shall not exceed an average of 0.2 milligrams per liter for 30 consecutive days.

The Electric Vehicle Research, Development, and Demonstration Act of 1975 (H.R. 8800) was introduced in the 94th Congress, 1st session. The bill authorizes a Federal program to promote electric vehicle technologies and demonstrate the commercial feasibility of electric vehicles. The research, development, and demonstration program would be carried out by the Energy Research and Development Administration (ERDA). The bill was read twice and referred to the Senate Committee on Commerce. If enacted, the legislation could have a major impact on lead-acid battery manufacturers and the lead-mining industry.

The Occupational Safety and Health Administration (OSHA) revised workplace standards for lead by reducing permissible employee-exposure limits from 200 micrograms to 100 micrograms per cubic meter of air based on an 8-hour time-weighted average. Implementation of the standard would require all employers in whose workplace there is lead, inorganic lead compounds, or organic lead salts, to make an initial determination of whether employee exposure to lead exceeds an "action level" of 50 micrograms per cubic meter of air. Where levels exceed the permissible 100-microgram limit, employers must use all "feasible engineering controls" to reduce exposures.

The full U.S. Circuit Court of Appeals for Washington granted a rehearing on a petition by EPA of a three-judge panel decision in December 1974 that ruled EPA's phasedown of lead-in-gasoline regulations were invalid. The rehearing was held on May 30, 1975, but no decision had been issued at yearend.

The International Lead and Zinc Study Group (ILZSG) held its 19th session in Geneva, Switzerland, November 3–8 to review the situation and outlook for lead and zinc. ILZSG provided estimates of production and consumption of lead and zinc that reflected changes brought about by the sharp downturn in world economic activity in 1975, and forecast increases in metal output and consumption in 1976 based on improved economic conditions. A review of new mine and smelter projects disclosed plans for several new secondary lead smelter projects and small increases in lead- and zinc-mine capacity in many countries.

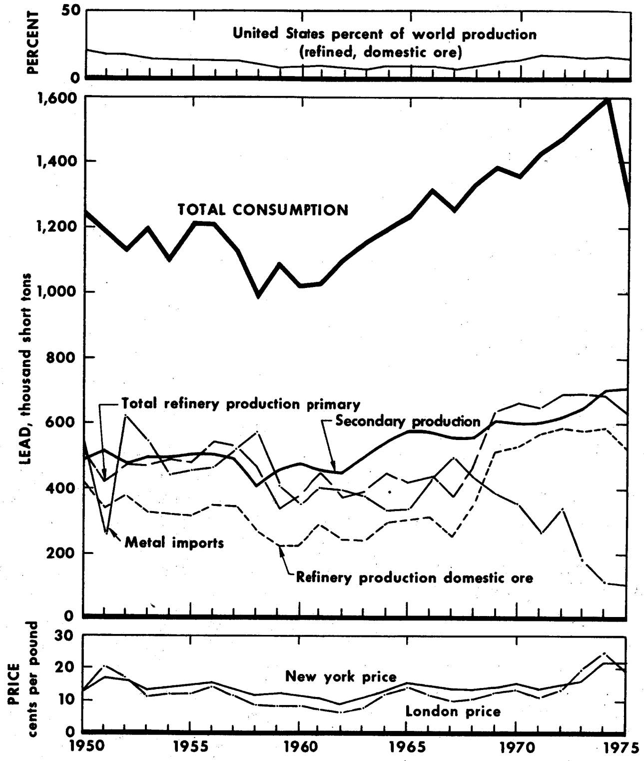

Figure 1.—Trends in the lead industry in the United States.

Table 1.—Salient lead statistics
(Short tons unless otherwise specified)

	1971	1972	1973	1974	1975
United States:					
Production:					
Domestic ores, recoverable lead content	578,550	618,915	603,024	663,870	621,464
Value ---- thousands	$159,679	$186,046	$196,465	$298,742	$267,230
Primary lead (refined):					
From domestic ores and base bullion	573,022	577,398	567,256	580,078	530,215
From foreign ores and base bullion	76,993	103,001	107,260	92,946	105,907
Antimonial lead (primary lead content)	16,116	8,185	13,223	9,867	2,125
Secondary lead (lead content)	596,797	616,597	654,286	698,698	658,456
Exports of lead materials, excluding scrap	5,925	8,376	66,576	61,982	21,256
Imports, general:					
Lead in ore and matte	65,998	101,282	109,947	94,299	87,560
Lead in base bullion	41	895	4	831	462
Lead in pigs, bars, and old	198,970	245,853	181,486	119,579	105,876
Stocks Dec. 31 (lead content):					
At primary smelters and refineries	121,660	145,573	89,847	121,051	156,530
At consumer plants	125,577	118,544	124,121	166,589	133,315
Consumption of metal, primary and secondary	1,431,514	1,485,254	1,541,209	1,599,427	1,297,098
Price: Common lead, average, cents per pound [1]	13.89	15.03	16.29	22.53	21.53
World:					
Production:					
Mine	3,742,950	3,801,094	r 3,843,723	r 3,832,499	3,787,804
Smelter	3,590,730	3,723,409	r 3,837,864	r 3,858,205	3,713,691
Price: London, common lead, average, cents per pound	11.52	13.68	19.47	26.83	18.73

r Revised.
[1] Quotation for 1971 at New York and for 1972–75 on a nationwide, delivered basis.

DOMESTIC PRODUCTION

MINE PRODUCTION

U.S. mine output of lead in 1975 dropped 6% to 621,500 tons from the record high achieved in 1974. Monthly production reached a maximum of 58,500 tons in March, about 6,500 tons less than the maximum achieved in October 1974. Production from Missouri mines decreased 8% to 516,000 tons and accounted for 83% of the Nation's total output of lead. Production in Idaho, which provided 8% of the total, was down 1,300 tons from the 1974 level. Colorado's production increased 2,500 tons, largely reflecting a substantial gain in ore treated at the Resurrection mine. Utah's output of lead rose 21% in 1975 from the more than 70-year low recorded in 1974. Lower production at Kennecott Copper Corp.'s Burgin mine was more than offset by new production at the Ontario mine near Park City, which began operations in May 1975. The Ontario mine is a joint venture of ASARCO Inc. and The Anaconda Company, and is managed by the latter.

The Buick mine, jointly owned by AMAX Lead Co. of Missouri and Homestake Mining Co., was the Nation's leading lead producer for the fifth consecutive year, with a record output of ore. However, lower lead and zinc grades kept lead-concentrate production at approximately the same level as in 1974, and zinc concentrate production was 9,400 tons less than in 1974. Ore milled in 1975 totaled 1.63 million tons averaging 11.7% lead and 3.6% zinc, from which 251,500 tons of lead concentrate and 45,800 tons of zinc concentrate were produced. Total ore reserves increased 1.6 million tons during the year to nearly 28.4 million tons at yearend. Average grade of the reserves was 7.1% lead and 2.0% zinc compared with an average of 8.1% lead and 2.2% zinc at yearend 1974.[2]

The seven leading mines, all in Missouri, contributed 79% of the total U.S. mine production of lead. The 12 leading mines produced 91%, and the 25 leading mines accounted for 99% of the total. About 4,600 persons were employed at the Nation's lead, lead-silver, and lead-zinc mines and mills in 1975. Output of lead and zinc from these mines was approximately 173 tons per man-year. Average grade of lead ore mined was 6.17% lead and 0.89% zinc, compared with 6.24% lead and 1.01% zinc in 1974.

In Missouri, St. Joe Minerals Corp., the Nation's largest lead-mining company, cut back operations at its four southeast Missouri mine-mill units during part of the year. The 1975 production of lead in concentrates was reported at 201,434 tons, 46,060 tons less than in 1974. St. Joe's four mine units—Fletcher, Viburnum, Indian Creek, and Brushy Creek—accounted for approximately one-third of U.S. mine production in 1975. The corporation reported that its productivity index, tons produced per man-shift worked underground, increased as a result of extensive automation from 30.8 at the older facilities to 56.8 at the newest, Brushy Creek[3]

In Idaho, Hecla Mining Co. reported that its Lucky Friday mine produced 173,245 tons of ore assaying 10.71% lead, 1.29% zinc, and 14.96 ounces of silver per ton in 1975, compared with 165,700 tons assaying 9.93% lead, 1.18% zinc, and 13.53 ounces of silver per ton in 1974. About 18,300 tons of lead was recovered in the concentrates produced. Ore reserves at Lucky Friday at yearend were 505,000 tons, compared with 539,000 tons reported a year earlier. Hecla also reported that ore production at the Star-Morning mine, jointly owned by Hecla (30%) and The Bunker Hill Co. (70%), increased slightly to 282,160 tons. Hecla's share of the 1975 production was 84,648 tons assaying 5.00% lead, 5.64% zinc, and 2.49 ounces of silver per ton. The concentrates produced yielded about 3,900 tons of lead. Hecla's 30% share of the computed ore reserves increased 18,000 tons to 394,000 tons at yearend.[4]

The Bunker Hill Co. reported that production from company owned and controlled mines aggregated 33,000 tons of lead, 2,000 tons more than in 1974. The company also reported that proven and probable ore reserves at yearend in the Bunker Hill mine totaled 3.08 million tons averaging 2.3% lead, 3.5% zinc, and 1.3 ounces of silver per ton. In addition,

[2] Homestake Mining Co. 1975 Annual Report. P. 8.

[3] St. Joe Minerals Corp. 1975 Annual Report. P. 6.

[4] Hecla Mining Co. 1975 Annual Report. Pp. 6–7.

the company's 70% interest in the proven and probable reserves of the Star mine totaled 699,000 tons averaging 7.1% lead, 7.8% zinc, and 4.1 ounces of silver per ton.[5]

In Colorado during 1975, Idarado Mining Co. treated 406,000 tons of lead-zinc-copper ore averaging 2.28% lead, 3.24% zinc, and 0.63% copper, compared with 396,600 tons averaging 2.46% lead, 3.33% zinc, and 0.55% copper treated in 1974. Ore reserves at yearend 1975 decreased 6% to 3.66 million tons averaging 3.05% lead, 4.42% zinc, and 0.67% copper. The company reported that major negative factors in 1975 were higher mine operating costs and sharply increased smelter treatment charges. At the Leadville Unit mine also known as the Resurrection mine, a joint venture of ASARCO, Inc. and Newmont Mining Corp., 203,000 tons of lead-zinc-silver ore was treated, about 40,000 tons more than in 1974. The average grade of ore milled in 1975 was 4.23% lead, 8.68% zinc, and 2.2 ounces silver per ton, compared with 4.49% lead, 9.60% zinc, and 2.5 ounces of silver per ton in 1974. Ore reserves at the Resurrection mine at yearend 1975 were estimated at 2.27 million tons averaging 5.1% lead, 9.9% zinc, and 2.7 ounces of silver per ton. Although total ore reserves declined 14% in 1975, the average grade was slightly higher than in 1974.[6]

SMELTER AND REFINERY PRODUCTION

Output of primary refined lead and lead in antimonial lead from the Nation's five primary refineries in 1975 totaled 638,247 tons, about 7% less than the 46-year production record achieved in 1974. About 83% of the total output was recovered from domestic ores, compared with 85% in 1974. Antimonial lead production at primary refineries dropped to 6,029 tons, less than one-half of 1974 production. The average antimony content of the alloy increased from 8.8% to 9.4%.

At the Herculaneum, Mo., smelter of St. Joe Minerals Corp., production of lead and lead alloys in 1975 totaled 185,890 tons, 19% less than in 1974. The falloff in metal production was attributed largely to a reduction in smelter operations to 60% of capacity during part of the year.[7]

ASARCO reported that its Omaha, Nebr., and Glover, Mo., refineries produced 200,100 tons of lead, about 8% less than in 1974. The company also reported that major environmental improvements were being designed at its El Paso, Tex., smelter to meet State air-quality standards. These include a totally enclosed ore-handling system, a new lead sinter plant, and an acid plant to treat sinter plant gases. At East Helena, Mont., a 400-ton-per-day acid plant was being constructed to meet clean air requirements. The East Helena smelter modifications and new facilities were scheduled for completion in 1977, and those at El Paso were to be completed in 1978. Base bullion produced at the East Helena and El Paso custom smelters were treated at the Omaha refinery. Most of the concentrate treated at the Glover smelter-refinery was produced at the Kennecott Copper Corp. Ozark mine at Sweetwater, Mo. The East Helena smelter processed ores and concentrates from about 125 domestic mines in 9 States and from mines in Australia, Canada, Colombia, and Peru. The El Paso smelter processed ores and concentrates from approximately 40 domestic mines in 8 States and from mines in Australia, Canada, Colombia, Honduras, Nicaragua, and Peru. The company reported that a new ventilating system was being installed to meet OSHA standards and that it had completed a closed-circuit water system to eliminate discharge of liquid effluent from the plant property.[8]

The AMAX-Homestake smelter-refinery at Boss, Mo., produced 136,000 tons of refined lead from the treatment of 197,000 tons of concentrates in 1975, 1,800 tons more lead than in 1974. Approximately one-half of the metal produced was derived from concentrates treated on toll. The company reported that gaseous and liquid effluents have been effectively controlled through close monitoring of the air and streams of the surrounding area.[9]

The Bunker Hill smelter-refinery of Gulf Resource and Chemical Corp. produced 123,000 tons of lead, about the same as in 1974. The company reported that productive operations approached capacity during the first 7 months of 1975

[5] Gulf Resources and Chemical Corp. 1975 Annual Report. P. 9.
[6] Newmont Mining Corp. 1975 Annual Report. Pp. 4, 9.
[7] Page 6 of work cited in footnote 3.
[8] ASARCO Inc. 1975 Annual Report. Pp. 9, 18.
[9] Page 8 of work cited in footnote 2.

despite periodic curtailments to meet environmental regulations governing the emission of sulfur oxides. More stringent regulations effective August 1, combined with unusually adverse weather conditions, necessitated more frequent and longer smelter interruptions and some loss of production in the fourth quarter. The Bunker Hill smelter processed concentrates from mines in seven States, and Canada, Greenland, and Peru.

Secondary smelter production from recycled materials in 1975 dropped nearly 6% below the record output of 1974 to 658,500 tons, about 51% of the total smelter and refinery production. Approximately 115 secondary plants were engaged in recovering lead and lead alloys from recycled scrap materials during the year. Five plants closed during the year. Secondary metal output represented about 51% of total lead consumption in 1975. Approximately 41% of the total secondary lead production was recovered in the form of lead metal, and the remainder, as antimonial lead and other lead alloys.

RAW MATERIAL SOURCES

Primary smelters and refineries processed ores and concentrates from domestic mines yielding 531,900 tons of refined lead and antimonial lead, about 83% of the total refinery production. Refined and antimonial lead recovered from imported concentrates smelted during the year totaled 106,400 tons, 9,440 tons more than in 1974. Lead recovered from lead scrap processed at primary plants increased nearly 1,800 tons to about 3,300 tons contained in antimonial lead.

Scrap materials consumed in 1975 totaled 909,300 tons, about 19,900 tons less than in 1974. New scrap in the form of purchased drosses and residues from a variety of sources aggregated 136,100 tons, about 15% of the total scrap processed, compared with 129,400 tons, about 14% of the total input, in 1974. The remainder, old scrap, was largely battery plates, with smaller quantities of cable lead, soft and hard lead, type metal, solder, and babbitt. A small amount of reclaimed scrap totaling about 5,400 tons in 1975 was imported for processing in domestic plants.

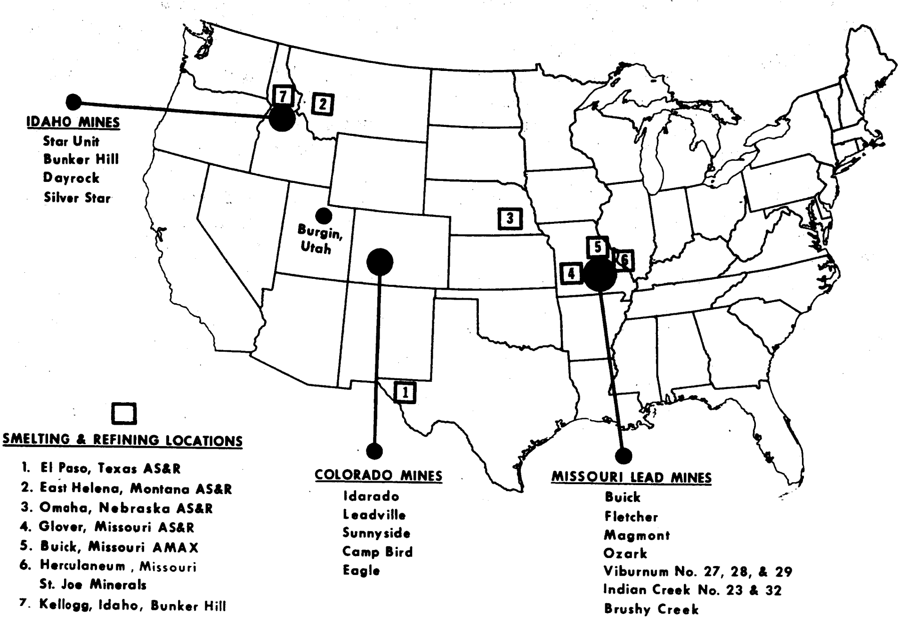

Figure 2.—Lead mines and smelters in the United States.

CONSUMPTION AND USES

Domestic consumption of lead in 1975 dropped to 1.30 million tons, 19% below the record high of 1974 and the lowest level of consumption since 1967. On a monthly basis, consumption ranged from a low of 88,600 tons in July to a high of nearly 133,700 tons in October. The use of lead declined in all major product categories. In metal products, battery requirements dropped 18%, ammunition was down 14%, and solders declined 13%. Lead used in pigments, principally red lead and litharge, was down 32%, and lead used in gasoline antiknock compounds decreased 17%. Miscellaneous and other unclassified uses of lead combined were 12% less than in 1974. According to type of material consumed, soft refined lead represented 66% of the total consumption; antimonial lead accounted for 29%; and lead in other alloys, mainly solders and bearing metals, accounted for 4%. Lead in copper-base scrap accounted for 1% of the total consumption.

The 18% falloff in lead requirements for battery grids and oxides was attributed essentially to the reduction in output of motor vehicles using batteries for starting, lighting, and ignition (SLI). Approximately 47.2 million batteries of this type were produced in 1975, 8.5 million less than in 1974. Of the total battery production, about 40.7 million were replacement and 6.5 million were original equipment. The 17% drop in the quantity of lead used in antiknock compounds in 1975 reflected a reduction in the average lead content per gallon of gasoline from about 1.9 grams per gallon in 1974 to approximately 1.7 grams per gallon in 1975. This was a result of increased production of unleaded gasoline, in conjunction with a decrease in the output of premium gasoline. Lead used in battery manufacture accounted for about 54% of total lead consumption. Lead requirements for antiknock compounds represented 16% of the total; pigments accounted for 6%; ammunition, 6%; miscellaneous and other unclassified uses, 3%; and other metal products, the remaining 15%.

The domestic supply of lead metal from all sources—primary and secondary production, imports for consumption, industry stock changes, and stockpile releases—totaled about 74,100 tons (5%) more than reported consumption and exports. The apparent excess supply in 1975 was attributed largely to unreported consumption, incomplete export data, and stock buildup, especially by small producers and dealers that do not report to the Bureau of Mines.

LEAD PIGMENTS

Pig lead used in the production of lead oxides and pigments totaled nearly 495,700 tons, about 11% less than in 1974. The quantity of lead used in making black oxide decreased 11% and accounted for 71% of the total lead in pigments. Litharge production was down 13% and accounted for 25% of the total pigment and oxide production in 1975. Most of the litharge and black oxide produced went to battery manufacturers. Litharge shipments for use in the ceramics industry dropped 27% and accounted for 28% of the total litharge shipments.

Prices.—The published price of basic carbonate white lead in carload lots, freight allowed, which had remained unchanged at 23.9 cents per pound through 1973 and 1974, was advanced to 32.5 cents per pound in January. It then remained unchanged through December 1975. The quoted price of red lead (Pb_3O_4) 95%, in carload lots at works, was unchanged at 29.25 cents per pound through May, then was reduced early in June to 27.75 to 28.0 cents, and remained unchanged thereafter to yearend. The price quotation on lead silicate ($PbSiO_2$) remained unchanged at 23 cents through mid-August, then was advanced to 25.05 to 26.05 cents per pound, remaining unchanged through December. Commercial-grade litharge in carload lots at works was quoted at 28.50 to 29.50 cents per pound through the first 5 months of 1975. The price was reduced in the first week in June to 27 to 27.75 cents, and reduced again in August to 24.50 cents, remaining unchanged thereafter to yearend.

The value of shipments of white lead, red lead, and litharge amounted to $59.4 million, an average of $428 per ton, compared with $89.2 million and $494 per ton in 1974.

Foreign Trade.—Exports of pigment-grade and other lead oxides totaled nearly 2,300 tons valued at $1.39 million. Shipments went to 33 countries. Imports for consumption of lead pigments and compounds increased 7% in quantity, but the value decreased 25% to $7.5 million. Litharge, which comprised 78% of the total quantity imported, increased 39%; imports of chrome yellow, comprising 16% of the total, were 43% less than in 1974. Nearly all of the imports of litharge came from Mexico; most of the chrome yellow came from Japan.

STOCKS

Inventories of refined and antimonial lead at primary smelters and refineries increased steadily during the first 7 months from about 37,300 tons at the beginning of the year to nearly 110,000 tons in July, then trended downward to 81,300 tons at yearend. Stocks of lead in base bullion were about 1,300 tons more than that of 1974, but lead in ore and matte stocks dropped 9,800 tons to 68,500 tons at yearend.

Stocks of lead in all forms at consumer and secondary smelter plants trended downward during the year from a high of 166,600 tons in January to a low of 114,100 tons in September, but rose to 133,300 tons at yearend. Refined soft lead constituted 64% of the total and lead in antimonial lead, 31%.

Stocks of refined lead, lead in antimonial lead, and lead in alloys at producers' and consumers' plants totaled 213,000 tons, representing about 2 months of domestic consumption. Stocks of new and old scrap at secondary smelters decreased about 9,000 tons to about 95,300 tons at yearend.

Lead stocks in LME warehouses increased steadily during the year from 21,760 tons early in January to 94,000 tons at yearend.

PRICES

The U.S. producer price for common and corroding-grade lead on a nationwide basis as reported by Metals Week remained unchanged at 24.50 cents per pound until May 1, when ASARCO reduced its price to 22.75 cents. ASARCO was followed by other producers, both primary and secondary, later in the month. ASARCO and other producers again reduced the price of lead from 22.75 cents to 19.00 cents in the first week in June, and this price remained unchanged until mid-August when the price was advanced 1 cent to 20 cents per pound. In mid-December, the producers' price was reduced to 19 cents per pound and remained at that value to yearend. The weighted average price for the year was 21.53 cents per pound, compared with 22.53 cents in 1974.

The LME cash bid price in terms of U.S. currency fluctuated in a narrow range near the U.S. producer price during the first quarter of the year, trending downward in April to an average of 21.73 cents. The price continued to decline from 20.93 cents on May 2 to 15.75 cents per pound on May 30, averaging 19.1 cents for the month. The average LME price for June was 15.99 cents. In July, the LME cash bid price ranged from 16.3 cents at the beginning of the month through a low of 15.8 cents at midmonth to 17.1 cents near monthend. In August, the price ranged between 16.8 cents and 17.9 cents, averaging 17.4 cents for the month. The LME price trended downward in the last 4 months to a low average of 15.10 cents in December. The equivalent average LME cash price for the year was 18.73 cents per pound (based on a monthly average Sterling Exchange rate of 222.15 cents), compared with an average 1974 price of 26.83 cents (with Sterling Exchange averaging 233.93 cents).

FOREIGN TRADE

Exports of lead metal, lead alloys, and lead in scrap materials totaled 71,200 tons, about 41% less than in 1974. Metal and alloy exports totaled nearly 21,300 tons, about one-third the quantity exported in 1974. Scrap exported (50,000 tons) was about 10,000 tons less than in 1974. On a monthly basis, metal exports ranged from a high of about 6,900 tons in April to a low of 150 tons in December, averaging 1,770 tons per month. Scrap exports ranged between a high of nearly 7,600 tons in April and a low of about 2,000 tons in August, and averaged 4,160 tons per month. More than 70% of the total wrought and unwrought metal exported went to Belgium-Luxembourg and the Netherlands. About one-third of the scrap shipments went to Canada, and the remainder, to about 21 other countries. In addition, 150,800 tons of lead and zinc concentrates valued at $31.5 million was exported. Although no breakdown by metal type or metal content is available, about 80% of the total shipments went to nine European countries and the remainder went to seven other countries.

General imports of lead materials into the United States in 1975 were nearly 10% less than in 1974. Receipts of lead in concentrates and other unrefined materials were down 7% to 87,560 tons, and metal receipts dropped 15% from the 1974 level of imports to about 100,500 tons, the smallest quantity of metal imported since 1939. The falloff in lead imports in 1975 was attributed essentially to decreased industrial demand and the high level of domestic stocks. The decline in imports of concentrates from Australia and Peru, 18% and 40%, respectively, was only partially offset by an 81% gain in receipts from Canada, a small increase in shipments from Honduras, and initial shipments from Greenland. Metal receipts from Canada and Peru, continuing a declining trend since 1972, were down 23% and 50%, respectively, in 1975. Shipments from Australia dropped to zero, but metal imports from Mexico were slightly higher than in 1974.

Canada was the leading supplier of crude lead materials, accounting for about one-third of total imports; shipments from Honduras, Australia, and Peru accounted for most of the remainder. Canada, Mexico, and Peru supplied 80% of the total metal imported.

Basic tariff rates remained unchanged in 1975 at 0.75 cent per pound on ore and concentrates and 1.0625 cents per pound on bullion, metal, and dross.

WORLD REVIEW

Mine production of lead in 1975 by market economy countries totaled 2.78 million tons, about 3% more than in 1974. Smelter production of lead in market economy countries, limited to primary metal where such information was available, totaled 2.65 million tons, slightly more than in 1974. Yugoslavia is included with market economy countries for the first time, accounting for the apparent gain in production. The mine production of centrally planned economy countries, except Yugoslavia, was estimated to be 1.01 million tons, and smelter production was about 1.06 million tons. It is likely that the imbalance results from the fact that some of the assigned smelter production includes metal from secondary sources.

World mine production declined 1% from 3.83 million tons in 1974 to 3.79 million tons in 1975, and smelter production dropped 4% from 3.86 million tons to 3.71 million tons.

The United States, the leading country in producing lead from mine sources, accounted for 16% of the world total. Other countries producing over 100,000 tons of lead in mined ore, in descending order of production, were the U.S.S.R., Australia, Canada, Peru, Mexico, Yugoslavia, Bulgaria, North Korea, and the People's Republic of China.

The United States was also the leading producer of refined lead. The U.S.S.R. probably ranked second, followed by Australia, Japan, Mexico, Canada, Yugoslavia, France, Belgium, Bulgaria, the People's Republic of China, North Korea, and West Germany; each of these 13 countries produced over 100,000 tons of lead and, collectively, accounted for 81% of world production. The smelter outputs assigned to Yugoslavia, Belgium, and Bulgaria may include recovery from secondary materials.

ILZSG reported preliminary data on consumption of refined lead in market economy countries as being at least 3.34 million tons in 1975, about 18% less than the final figure of 4.07 million tons reported for 1974. The United States was the leading consuming country, accounting for 34% of world market economy consumption. Consumption figures include metal from secondary sources. The group's reports of world lead-metal production indicate a surplus of production over consumption of approximately 87,000 tons in 1975. The surplus was probably added to producers' stocks.

Australia.—Mine production of lead increased 8% over that of 1974 to 448,700 tons in 1975. Australia was the world's third-ranking source of mined lead. Broken

Hill mines, operated close to capacity by Zinc Corporation and New Broken Hill Consolidated, produced 178,000 tons (lead content). Mount Isa Mines Ltd. increased lead production by a small margin, producing lead concentrate from silver-lead-zinc ores and smelting the concentrate to bullion at the mine site.

The combined production of refined lead and lead bullion in Australia was 342,600 tons, 8% less than 1974 output. Mount Isa Mines produced 145,000 tons of lead bullion for further refining in the United Kingdom. Broken Hill Associated Smelter Pty. Ltd. at Port Pirie produced 184,000 tons as refined lead, and Sulphide Corp. Pty. Ltd. produced 23,000 tons of lead bullion for refining elsewhere.

Consumption of primary lead in Australia declined 2% in 1975 to a total of 53,000 tons. Batteries accounted for 48% of the total; cable covering, 15%; pigments and chemicals, 10%; sheet and pipe, 9%; and other lead products, 18%. Secondary lead, used mainly by the battery industry, probably added 35,000 tons or more to primary usage.

One of the world's large undeveloped resources of lead is in the McArthur River area in the Northern Territories. During 1975, M.I.M. Holdings Ltd., parent of Mount Isa Mines Ltd., initiated a $7 million program of metallurgical testing for a feasibility study. The complex nature of the lead and zinc sulfides in the deposits posed a difficult beneficiation problem. The deposit was estimated to contain 209 million tons averaging 9.5% zinc, 4.1% lead, and 40 grams of silver per ton.

M.I.M. continued development of the Hilton mine 11 miles northeast of Mount Isa. Work included bulk ore sampling for pilot plant tests.

Bolivia.—Corporación Minera de Bolivia (COMIBOL) provided a large part of Bolivia's foreign exchange earnings through metal exports. The recent increases in the development of Bolivian mines created a market for sales of U.S. mining machinery and equipment. Although lead is not the major mineral product, COMIBOL exported 15,700 tons of lead in 1975 and produced 13,040 tons from six of the mines that it operated. Other minerals beside lead showed an excess of exports over production in 1975. The "medium miners" and "small miners" added to the export tonnage to make total exports of 19,500 tons of lead, mainly as concentrates.

Empresa Nacional de Fundiciones (ENAF) and COMIBOL formed a joint company in 1975 to construct a $35 million lead-silver smelter with a capacity of 27,500 tons of lead and 4.8 million troy ounces of silver per year. Construction was to begin in 1978. Reserves of lead ore estimated by COMIBOL at the end of 1975 were 2,300,000 tons containing 57.300 tons of lead.

Burma.—The Burmese Government planned to modernize the Bawdwin lead-zinc mine with West German financial assistance. Burmese production was 11,600 tons of refined lead, mainly from the Bawdwin mine. In fiscal year 1974–75, the Bawdwin mine produced over 166,000 tons of ore from which lead, antimonial lead, zinc, copper, nickel, and silver were recovered.

Canada.—Mine production of lead in ores and concentrates was restrained by world economic conditions in 1975 but recovered in part from the low level of 1974 to about 395,000 tons, a 12% increase. Production of primary refined lead increased 36% to 190,000 tons in 1975.

The 1974 ruling concerning dumping of lead imports into the United States was directed against Canada and Australia. In 1975, Canadian producers filed a petition seeking revocation of the findings and the U.S. International Trade Commission scheduled a hearing in July 1975. Hearings were postponed until January 1976 and, subsequently, the dumping tariffs were removed. Despite the repressive influence of the dumping hearings, Canada remained the largest source of U.S. imports of lead, providing 31% of the total of concentrates and metal imported. Of the total U.S. imports from Canada in 1975, 29,000 tons were in concentrates and 31,000 tons as metal, compared with 1974 imports of 16,000 tons in concentrates and 40,000 tons as metal.

Mine output of lead was from zinc-lead mines in eight territories and Provinces: Yukon Territory, 37%; British Columbia, 20%; Northwest Territories, 20%; New Brunswick, 17%; Newfoundland, 3%; Ontario, 2%; and Quebec and Manitoba each, less than 1%. The largest producer, Cyprus Anvil Mining Corp. at Faro, Yukon Territory, milled 3,225,000 tons of ore containing 129,000 tons of lead. The second- and third-ranking sources were Pine Point Mines, Ltd., in the Northwest Territories, producing about 75,000 tons, and the Sullivan mine at Trail, British Columbia, producing in the range of 70,000 to 76,000 tons of lead. The Brunswick Mining and Smelting Co., a subsidiary of Noranda Mines Ltd. in New Brunswick produced 59,700 tons of lead, principally from the No. 6 mine. The Buchans mine in Newfoundland, operated by ASARCO, produced concentrates containing 11,900 tons of lead.

Canadian lead-metal production came from the Cominco Ltd. smelter and refinery at Trail, British Columbia, and the Brunswick smelter at Belledune, New Brunswick. The Cominco plant produced 138,000 tons and the Brunswick smelter produced 50,900 tons of lead in 1975, but both operated far below their rated annual capacities of 225,000 and 70,000 tons, respectively.

The excess of lead concentrate production over that treated at the two smelters was exported to Japan, 40%; West Germany, 16%; the United States, 14%; the United Kingdom, 8%; Belgium, 7%; France, 1%; and the balance (14%) to other countries.

Ireland.—The Tynagh mine in County Galway, owned by Irish Base Metals Ltd. (a subsidiary of Northgate Exploration Ltd.), operated throughout 1975, producing 648,000 tons of ore with a grade of 3.94% lead, 4.27% zinc, 0.19% copper, and 1.64 ounces of silver per ton. The direct operating costs reported for 1975 were $13.78 per ton of ore mined.

The mine at Silvermines in County Tipperary, operated by Mogul of Ireland Ltd., milled 914,000 tons of ore containing 2.36% lead and 6.58% zinc. Total operating costs were approximately $12 million, or $13.17 per ton of ore.

Two companies continued development of the zinc-lead mines at Navan. Tara Exploration and Development Co. Ltd., the discoverer of the deposit, reported that its expected production would be 2.5 million tons per year of ore, starting in early 1977. Ore stockpiled from development work prior to June 1975 was 105,000 tons, with an estimated grade of 11.4% zinc and 2.4% lead. During 1975, Tara reached agreement with the Irish Government concerning terms of a lease giving 25% equity to the State and a royalty equal to 4.5% of profits. The other company, Bula Ltd., started to develop the upper end of the Navan ore deposit and also reached an agreement with the Irish Government granting the State a 49% interest. Bula planned to mine at a rate of 1.2 million tons per year by open pit and underground methods. Both companies agreed to send a portion of their concentrates to an Irish zinc refinery if and when such a facility is constructed. Until then, concentrates would presumably be shipped to European smelters.

Japan.—Japanese lead smelters operated at 70% of capacity during the early months of 1975 but were operating at 90% of capacity by March 31, 1976, the end of the fiscal year. Domestic mine production of lead ores contributed 55,700 tons of lead content to Japanese smelter production. Sales in fiscal 1975 were 228,000 tons of lead. Sales were divided between the major producing companies as follows: Nippon Mining Co. Ltd. 12%, Mitsubishi Metal Corp. 22%, Mitsui Mining and Smelting Co. Ltd. 17%, Sumitomo Metal Mining Co. Ltd. 11%, Dowa Mining Co. Ltd. 8%, and Toho Zinc Co. Ltd. 30%. Construction of additions to its lead smelter by Dowa at Kosaka was deferred beyond 1975. Lead exports in 1975 were 43,500 tons and imports were 15,307 tons.

Mexico.—Lead production in 1975 was adversely affected by decreased world demand and lower prices, with an 18% decrease from 240,000 tons in 1974 to 198,000 tons in 1975. Exports as bars or unrefined lead were 111,000 tons.

The Peñoles group continued construction of a smelter and refinery complex for lead and silver at Torreon, Coahuila, designed to achieve a capacity of 209,000 tons and representing an investment of $36 million. Industrial Minera Mexico, S.A., had expansion programs underway at several of its mining units designed to increase its capacity to process lead, zinc, and copper ores. Placer Development of Canada (34%), a Mexican financial group—Bancomer (33%)—and Comisión de Fomento Minero (33%) participated in Explomin, S.A. de C.V., to explore and develop the Real de Angeles silver-zinc-lead property in Zacatecas.

Late in 1975, proposed reforms to the Mining Law of 1961 were approved by the Congress, giving the Government greater control over and more participation in mining activity. The changes provided for a reduction in private sector participation, the establishment of quotas per mining unit, and restrictions on Mexicanized privately owned companies. The Government hoped that the reforms would promote greater activity by small miners and an increase in exploration to be financed by Government agencies.

Spain.—Lead-metal production in Spain was expected to grow from 81,000 tons in 1975 to as much as 140,000 tons in the next 5 years. Mine production of lead in 1975 was 64,000 tons from a complex of 77 mines and 30 treatment plants. The construction of the Rubiales zinc-lead mine and concentrator continued in 1975 and was expected to add 16,500 tons of lead concentrate to Spanish production when completed in 1977. Spain consumed 127,500 tons of lead in 1975; the apparent deficit in lead was made up by imports of concentrates and metal.

U.S.S.R.—Trade data published by ILZSG disclosed that the U.S.S.R. imported 65,500 tons of lead metal from Japan, North Korea, Peru, the United Kingdom, West Germany and Yugoslavia, and exported 11,800 tons to Finland and the Netherlands. Another source estimated that total lead-metal exports were 109,000 tons and imports were 62,500 tons. The World Bureau of Metal Statistics estimated mine production of lead in the U.S.S.R. in 1975 as 556,000 tons and consumption as 602,000 tons. Secondary lead production was estimated to be 105,000 tons.

Yugoslavia.—The program of expanding lead and zinc production continued in 1975; $15 million was budgeted for the lead share, with the aim of achieving a production of almost 200,000 tons of lead by 1980. Smelter production in 1975 was estimated at 139,000 tons of primary refined lead. Lead and zinc ores were produced from 18 mines and treated at 14 flotation plants, with concentrates going to 2 lead smelters, 1 Imperial lead-zinc smelter, and 1 lead refinery. Trepca was the major producer, with a mine at Stari Trg and a smelter and refinery at Zvecan, all in Serbia.

At the Trepca smelter, work continued on improving the sulfuric acid plant. The plant had not been in continuous operation after its construction in 1967 because of problems resulting from the low concentration of SO_2 in smelter gases. During 1975, workers were affected by gas exposure and lead poisoning, and the proposed continuous operation of the sulfuric acid plant in 1976 was intended to improve working conditions.

TECHNOLOGY

Bureau of Mines metallurgists developed a method for recovering lead from lead battery scrap that eliminates virtually all of the SO_2 normally emitted when a reverberatory or blast furnace is used. The method employs a hydrometallurgical step to convert the $PbSO_4$ to PbO and $CaSO_4$ by mixing the battery scrap with a slurry of $Ca(OH)_2$. The dried product is mixed with a KCl-NaCl flux and carbon and reduced at 650° C. The process produces lead reductions and recoveries as high as 97.0% and 94.9%, respectively. The KCl-NaCl flux is recovered.[10]

Researchers at the Bureau of Mines Reno Metallurgy Research Center investigated an alternative hydrometallurgy procedure for reducing lead sulfide concentrates that does not generate gaseous sulfur oxides and diminishes the potential for the emission of lead into the atmosphere. The procedure involves leaching galena flotation concentrate with ferric chloride ($FeCl_3$) solution to obtain lead chloride ($PbCl_2$) and elemental sulfur. High-purity $PbCl_2$ crystallizes from the leach filtrate on cooling and is electrolyzed in a low-temperature fused-salt cell to obtain corroding-grade metal. Spent leach solution ($FeCl_3$) is regenerated for further use. Other associated metals such as silver, copper, and zinc are recovered by additional steps. The process is suitable for small-scale operation, is not capital intensive, requires little labor, and can extract over 99% of the lead in concentrate in minutes.[11]

A closed lead-acid battery-reclamation furnace originally developed by Varta Batterie AG (West Germany) will be installed by Britannia Lead Co. in the United Kingdom. The furnace is designed

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[10] Wilson, D. A. A New Sulfur Dioxide-Free Process for Recovering Lead From Battery Scrap. BuMines RI 8123, 1976, 13 pp.

[11] Haver, F. P., and M. M. Wong. Ferric Chloride-Brine Leaching of Galena Concentrate. BuMines RI 8105, 1976, 17 pp.

to provide a closed operating system and achieves high temperatures using oxygen in the blast area combined with a series of afterburner chambers to complete the combustion process by insuring that all hydrocarbon particles are burned. In addition to environmental advantages, the furnace, by processing whole batteries and obviating hand operation, minimizes safety and health hazards to workers.[12]

E. I. duPont de Nemours & Co. announced the discovery of a new type of catalyst that showed promise of operating on leaded fuel while meeting the most stringent automobile emission standards. These new catalysts are based on the introduction of noble metals into a synthetic perovskite structure, where they are locked into place by other elements of the structure. These other elements reportedly provide the noble metal protection against the harmful materials typically found in exhaust gases and provide the catalysts with thermal stability.

DuPont, as a major producer of tetraethyl lead additives for gasoline, developed data showing that using leaded gasoline with the new catalyst would result in a net fuel savings over the use of unleaded fuel. According to the DuPont study, the addition of 2 grams of lead per gallon of gasoline would increase the octane rating from 87.5 to 95. Using leaded gasoline of a 95-octane rating could result in a net crude oil savings of about 6% compared with 91-octane unleaded fuel.[13]

Ethyl Corp. continued testing its lead-compatible emissions control system, called the Turbulent Flow System (TFS), and reported that automotive emissions have been reduced below levels required by the 1975–76 U.S. 49-State standards using leaded gasoline. TFS uses a turbulent-flow intake manifold, which improves the fuel and air mixture and distributes it more evenly to the cylinders. The process permits the engine to operate efficiently without misfire using lean mixtures.[14]

The International Lead Zinc Research Organization (ILZRO) reported that much of its research activity was directed toward the lead-acid battery, the lead industry's largest single market on a world basis. Significant progress also was reported in areas of environmental health, ceramics, architecture, and metallurgy, where intensive research on lead was conducted.

A study on charging methods for lead-acid batteries disclosed that gas-controlled systems are potentially more efficient than conventional charging systems. In addition, they can result in prolonged life because they avoid elevated temperatures associated with overcharging and excessive gassing, which loosen active materials from the plate structure during overcharge.

Several improvements achieved in the performance of prototype battery-powered electric vehicles, designed and built as part of an ILZRO project, were turned over to defense agencies for further testing. Cooperative research with ERDA and the Electric Power Research Institute (EPRI) was planned to establish the viability of existing lead-acid battery technology in load-leveling applications. A cell and battery system was being designed for this application.

Design criteria for ceramic glazes were developed that minimize lead release from dinnerware. Safe lead glazes can be made by keeping the molar ratio of modifying ions (alkalies or alkaline earths) to silica below 0.7. Another project showed that production of ceramic tiles from lead slags was commercially viable and that the resulting products could be made in various colors at a savings of about 40% of the cost of regular tiles.[15]

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[12] Tech. Survey. V. 32 No. 23, June 5, 1976, p. 16.
[13] Chemical Week. V. 117, No. 11, Sept. 10, 1975, pp. 39, 42.
[14] Ethyl Corp. 1975 Annual Report. P. 12.
[15] Lead Industries Association, Inc. 1975 Annual Review. P. 9.

Table 2.—Mine production of recoverable lead in the United States, by State

(Short tons)

State	1971	1972	1973	1974	1975
Alaska	--	--	6	--	--
Arizona	859	1,763	763	1,059	420
California	2,284	1,153	44	35	66
Colorado	25,746	31,346	28,112	24,609	27,088
Idaho	66,610	61,407	61,744	51,717	50,395
Illinois	1,238	1,335	541	493	W
Kentucky	--	--	--	--	(1)
Maine	--	85	204	279	364
Missouri	429,634	489,397	487,143	562,097	515,958
Montana	615	287	176	154	205
Nevada	111	(1)	--	1,785	2,976
New Mexico	2,971	3,582	2,556	2,364	1,931
New York	877	1,089	2,304	3,076	3,027
Oklahoma	--	--	--	W	--
Oregon	--	--	--	W	W
Utah	38,270	20,706	13,733	10,510	12,679
Virginia	3,386	3,441	2,637	3,106	2,551
Washington	5,177	2,567	2,217	1,299	W
Wisconsin	752	757	844	1,285	W
Other States	20	--	--	2	3,804
Total	578,550	618,915	603,024	663,870	621,464

W Withheld to avoid disclosing individual company confidential data; included in "Other States."
[1] Less than ½ unit.

Table 3.—Production of lead and zinc in the United States in 1975, by State and class of ore, from old tailings, etc., in terms of recoverable metals

(Short tons)

State	Lead ore			Zinc ore			Lead-zinc ore		
	Gross weight (dry basis)	Lead content	Zinc content	Gross weight (dry basis)	Lead content	Zinc content	Gross weight (dry basis)	Lead content	Zinc content
Arizona	535	42	--	--	--	--	2,595	146	267
California	--	--	--	2,160	42	197	--	--	--
Colorado	900	33	--	177,494	1,690	13,118	564,911	15,776	23,692
Idaho	188,319	18,370	1,846	(1)	(1)	(1)	1,073,643	30,912	37,085
Kentucky	--	--	--	--	--	--	--	--	--
Maine	--	--	--	--	--	--	--	--	--
Missouri	8,467,794	515,958	74,867	--	--	--	--	--	--
Montana	209	20	1	--	--	--	81	5	5
Nevada	250	5	1	800	5	14	390,170	2,604	5,428
New Jersey	--	--	--	191,220	--	31,105	--	--	--
New Mexico	--	--	--	(1)	(1)	(1)	--	--	--
New York	--	--	--	1,246,733	3,027	76,612	--	--	--
Pennsylvania	--	--	--	471,342	--	21,090	--	--	--
Tennessee	--	--	--	3,105,719	--	78,633	--	--	--
Utah	964	101	16	--	--	--	289,754	12,578	19,624
Virginia	--	--	--	620,121	2,551	15,151	--	--	--
Other States [2]	25	--	--	421,047	885	9,210	306,534	1,849	10,131
Total	8,658,996	534,529	76,731	6,236,636	8,200	245,130	2,627,688	63,870	96,232
Percent of total lead-zinc	--	86	16	--	1	52	--	10	21

See footnotes at end of table.

Table 3.—Production of lead and zinc in the United States in 1975, by State and class of ore, from old tailings, etc., in terms of recoverable metals—Continued

(Short tons)

State	Copper-lead, copper-zinc, and copper-lead-zinc ores			All other sources [3]			Total		
	Gross weight (dry basis)	Lead content	Zinc content	Gross weight (dry basis)	Lead content	Zinc content	Gross weight (dry basis)	Lead content	Zinc content
Arizona	94,608	--	8,366	39,260,759	232	22	39,358,497	420	8,655
California	--	--	--	23,639	24	9	25,799	66	206
Colorado	408,800	7,704	10,825	134,904	1,885	825	1,287,009	27,088	48,460
Idaho	--	--	--	[1]548,233	[1]1,113	[1]1,995	1,810,195	50,395	40,926
Kentucky	--	--	--	--	--	41	--	--	41
Maine	211,211	364	8,318	--	--	--	211,211	364	8,318
Missouri	--	--	--	--	--	--	8,467,794	515,958	74,867
Montana	--	--	--	21,153	180	104	21,443	205	110
Nevada	13,000	355	49	1,491	7	4	405,711	2,976	5,496
New Jersey	--	--	--	--	--	--	191,220	--	31,105
New Mexico	--	--	--	[1]1,778,742	[1]1,931	[1]11,015	1,778,742	1,931	11,015
New York	--	--	--	--	--	--	1,246,733	3,027	76,612
Pennsylvania	--	--	--	--	--	--	471,342	--	21,090
Tennessee	1,634,845	--	4,660	--	--	--	4,740,564	--	83,293
Utah	--	--	--	--	--	--	290,718	12,679	19,640
Virginia	--	--	--	--	--	--	620,121	2,551	15,151
Other States [2]	--	--	--	65,987	1,070	5,029	793,593	3,804	24,370
Total	2,362,464	8,423	32,218	41,834,908	6,442	19,044	61,720,692	621,464	469,355
Percent of total lead-zinc	--	2	7	--	1	4	--	100	100

[1] Zinc ore and ore from "Other sources" combined to avoid disclosing individual company confidential data.
[2] Other States includes Illinois, Oregon, Washington, and Wisconsin.
[3] Lead and zinc recovered from copper, gold, silver, and fluorspar ores, and from mill tailings and miscellaneous cleanups.

Table 4.—Mine production of recoverable lead in the United States, by month

(Short tons)

Month	1974	1975	Month	1974	1975
January	57,149	55,578	August	58,670	48,065
February	52,785	52,575	September	49,975	50,640
March	57,956	58,485	October	64,919	56,327
April	52,297	56,005	November	53,222	49,019
May	53,348	53,277	December	53,902	52,858
June	54,884	50,813			
July	54,763	37,822	Total	663,870	621,464

Table 5.—Twenty-five leading lead-producing mines in the United States in 1975, in order of output

Rank	Mine	County and State	Operator	Source of lead
1	Buick	Iron, Mo	AMAX Lead Co. of Missouri	Lead-zinc ore.
2	Fletcher	Reynolds, Mo	St. Joe Minerals Corp	Lead ore.
3	Magmont	Iron, Mo	Cominco American, Inc	Do.
4	Ozark	Reynolds, Mo	Ozark Lead Co	Do.
5	Brushy Creek	do	St. Joe Minerals Corp	Do.
6	Viburnum No. 29	Washington, Mo	do	Do.
7	Viburnum No. 28	Iron, Mo	do	Do.
8	Bunker Hill	Shoshone, Idaho	The Bunker Hill Co	Lead-zinc ore.
9	Lucky Friday	do	Hecla Mining Co	Lead ore.
10	Indian Creek	Washington, Mo	St. Joe Minerals Corp	Do.
11	Star Unit	Shoshone, Idaho	Hecla Mining Co	Lead-zinc ore.
12	Viburnum No. 27	Crawford, Mo	St. Joe Minerals Corp	Lead ore.
13	Leadville Unit	Lake, Colo	ASARCO, Inc	Lead-zinc and lead-zinc-copper ores.
14	Idarado	Ouray and San Miguel, Colo	Idarado Mining Co	Copper-lead-zinc ore.
15	Burgin	Utah, Utah	Kennecott Copper Corp	Lead-zinc and lead ores.
16	Ontario	Summit, Utah	Park City Ventures	Lead-zinc ore.
17	Sunnyside	San Juan, Colo	Standard Metals Corp	Do.
18	Balmat	St. Lawrence, N.Y	St. Joe Minerals Corp	Zinc ore.
19	Pan American	Lincoln, Nev	St. Patrick Mining Co. Inc	Lead-zinc ore.
20	Austinville and Ivanhoe.	Wythe, Va	The New Jersey Zinc Co	Zinc ore.
21	Camp Bird	Ouray, Colo	Federal Resources Corp	Lead-zinc ore.
22	Emperius	Mineral, Colo	Minerals Engineering Co	Do.
23	Ground Hog	Grant, N. Mex	ASARCO, Inc	Zinc ore.
24	Pend Oreille	Pend Oreille, Wash	The Bunker Hill Co	Lead-zinc ore.
25	Eagle	Eagle, Colo	The New Jersey Zinc Co	Zinc and copper ores.

Table 6.—Refined lead produced at primary refineries in the United States, by source material

(Short tons)

	1971	1972	1973	1974	1975
Refined lead: [1]					
From primary sources:					
Domestic ores and base bullion	573,022	577,398	567,256	580,078	530,215
Foreign ores and base bullion	76,993	103,001	107,260	92,946	105,907
Total	650,015	680,399	674,516	673,024	636,122
From secondary sources	1,223	1,189	--	--	--
Grand total	651,238	681,588	674,516	673,024	636,122
Calculated value of primary refined lead (thousands) [2]	$180,574	$204,528	$219,757	$303,265	$273,914

[1] GSA metal is not included in refined lead production.
[2] Value based on average quoted price and excludes value of refined lead produced from scrap at primary refineries.

Table 7.—Antimonial lead produced at primary lead refineries in the United States

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1971	19,686	1,191	6.0	12,247	3,869	2,379	18,495
1972	15,051	1,050	7.0	6,136	2,049	5,816	14,001
1973	15,455	1,167	7.5	9,020	4,203	1,065	14,288
1974	12,513	1,097	8.8	5,879	3,988	1,549	11,416
1975	6,029	567	9.4	1,658	467	3,337	5,462

Table 8.—Stocks and consumption of new and old lead scrap in the United States in 1975

(Short tons, gross weight)

Class of consumer and type of scrap	Stocks Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks Dec. 31
Smelters and refineries:						
Soft lead	2,180	33,552	--	32,642	32,642	3,090
Hard lead	2,449	27,137	--	26,912	26,912	2,674
Cable lead	2,629	48,664	--	50,569	50,569	724
Battery-lead plates	58,877	618,724	--	623,448	623,448	54,153
Mixed common babbitt	398	3,272	--	3,515	3,515	155
Solder and tinny lead	526	10,940	--	11,250	11,250	216
Type metals	2,927	19,282	--	19,820	19,820	2,389
Drosses and residues	34,159	133,755	136,066	--	136,066	31,848
Total	104,145	895,326	136,066	768,156	904,222	95,249
Foundries and other manufacturers:						
Soft lead	--	--	--	--	--	--
Hard lead	--	--	--	--	--	--
Cable lead	--	--	--	--	--	--
Battery-lead plates	--	--	--	--	--	--
Mixed common babbitt	2	5,040	--	5,037	5,037	5
Solder and tinny lead	--	--	--	--	--	--
Type metals	--	--	--	--	--	--
Drosses and residues	--	--	--	--	--	--
Total	2	5,040	--	5,037	5,037	5
All consumers:						
Soft lead	2,180	33,552	--	32,642	32,642	3,090
Hard lead	2,449	27,137	--	26,912	26,912	2,674
Cable lead	2,629	48,664	--	50,569	50,569	724
Battery-lead plates	58,877	618,724	--	623,448	623,448	54,153
Mixed common babbitt	400	8,312	--	8,552	8,552	160
Solder and tinny lead	526	10,940	--	11,250	11,250	216
Type metals	2,927	19,282	--	19,820	19,820	2,389
Drosses and residues	34,159	133,755	136,066	--	136,066	31,848
Grand total	104,147	900,366	136,066	773,193	909,259	95,254

Table 9.—Secondary metal recovered[1] from lead and tin scrap in the United States in 1975, by type of product

(Short tons)

	Lead	Tin	Antimony	Other	Total
Refined pig lead	211,594	--	--	--	211,594
Remelt lead	59,703	--	--	--	59,703
Total	271,297	--	--	--	271,297
Refined pig tin	--	1,862	--	--	1,862
Remelt tin	--	252	--	--	252
Total	--	2,114	--	--	2,114
Lead and tin alloys:					
Antimonial lead	315,120	487	14,768	383	330,758
Common babbitt	10,769	483	849	4	12,105
Genuine babbitt	31	144	9	3	187
Solder	21,155	4,865	392	19	26,431
Type metals	15,991	966	1,841	1	18,799
Cable lead	9,939	--	97	--	10,036
Miscellaneous alloys	874	65	8	19	966
Total	373,879	7,010	17,964	429	399,282
Tin content of chemical products	--	738	--	--	738
Grand total	645,176	9,862	17,964	429	673,431

[1] Most of the figures herein represent actual reported recovery of metal from scrap.

Table 10.—Secondary lead recovered in the United States

(Short tons)

	1971	1972	1973	1974	1975
As metal:					
At primary plants	1,223	1,189	--	--	--
At other plants	148,911	172,168	186,124	238,216	271,297
Total	150,134	173,357	186,124	238,216	271,297
In antimonial lead:					
At primary plants	2,379	5,816	1,065	1,549	3,337
At other plants	340,333	340,066	374,713	369,954	311,783
Total	342,712	345,882	375,778	371,503	315,120
In other alloys	103,951	97,358	92,384	88,979	72,039
Grand total:					
Quantity	596,797	616,597	654,286	698,698	658,456
Value (thousands)	$165,790	$185,349	$213,166	$314,833	$283,531

Table 11.—Lead recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

Kind of scrap	1974	1975	Form of recovery	1974	1975
New scrap:			As soft lead:		
Lead-base	92,680	90,712	At primary plants	--	--
Copper-base	4,792	3,252	At other plants	238,216	271,297
Tin-base	281	250			
			Total	238,216	271,297
Total	97,753	94,214			
			In antimonial lead[1]	371,503	315,120
Old scrap:			In other lead alloys	72,597	58,485
Battery-lead plates	418,400	417,489	In copper-base alloys	16,361	13,523
All other lead-base	169,184	136,280	In tin-base alloys	21	31
Copper-base	13,359	10,471			
Tin-base	2	2	Total	460,482	387,159
Total	600,945	564,242	Grand total	698,698	658,456
Grand total	698,698	658,456			

[1] Includes 1,549 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1974 and 3,337 in 1975.

Table 12.—Lead consumption in the United States, by product

(Short tons)

Product	1974	1975	Product	1974	1975
Metal products:			Pigments—Continued:		
Ammunition	87,090	75,081	Pigment colors	17,336	10,618
Bearing metals	14,609	12,184	Other[1]	718	499
Brass and bronze	22,240	13,404			
Cable covering	43,426	22,099	Total	116,213	79,072
Calking lead	19,739	14,296			
Castings metals	7,507	7,711	Chemicals:		
Collapsible tubes	2,488	2,216	Gasoline antiknock		
Foil	4,404	3,205	additives	250,502	208,605
Pipes, traps, bends	16,455	14,233	Miscellaneous chemicals	708	181
Sheet lead	21,294	24,859			
Solder	66,280	57,344	Total	251,210	208,786
Storage batteries:					
Battery grids,			Miscellaneous uses:		
posts, etc	391,479	326,714	Annealing	4,097	2,629
Battery oxides	460,402	372,700	Galvanizing	1,664	1,228
Terne metal	2,300	1,511	Lead plating	498	376
Type metal	20,516	16,211	Weights and ballast	21,418	20,018
Total	1,180,229	963,768	Total	27,677	24,251
			Other, unclassified uses	24,098	21,221
Pigments:					
White lead	1,996	2,498	Grand total[2]	1,599,427	1,297,098
Red lead and litharge	96,163	65,457			

[1] Includes lead content of leaded zinc oxide and other pigments.
[2] Includes lead which went directly from scrap to fabricated products.

Table 13.—Lead consumption in the United States, by month

(Short tons)

Month	1974	1975	Month	1974	1975
January	140,971	105,091	August	143,953	115,510
February	129,404	98,866	September	143,712	122,985
March	130,884	99,216	October	156,780	133,696
April	126,500	105,105	November	136,434	115,757
May	142,615	102,255	December	113,842	115,323
June	121,530	94,700			
July	112,802	88,594	Total [1]	1,599,427	1,297,098

[1] Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide and other pigments.

Table 14.—Lead consumption in the United States in 1975, by class of product and type of material

(Short tons)

Product	Soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
Metal products	146,402	56,050	51,498	10,404	264,354
Storage batteries	393,583	304,353	1,478	--	699,414
Pigments	78,914	158	--	--	79,072
Chemicals	208,786	--	--	--	208,786
Miscellaneous	12,138	12,088	25	--	24,251
Unclassified	19,437	1,282	502	--	21,221
Total	859,260	373,931	53,503	10,404	[1]1,297,098

[1] Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide and other pigments.

Table 15.—Lead consumption in the United States in 1975, by State [1]

(Short tons)

State	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
California	104,197	37,738	3,691	290	145,916
Colorado	657	267	37	--	961
Connecticut	9,281	8,031	--	706	18,018
District of Columbia	139	--	--	--	139
Florida	8,026	8,101	--	--	16,127
Georgia	51,484	23,636	552	8	75,680
Illinois	74,519	39,109	7,956	1,090	122,674
Indiana	102,728	31,362	2,437	300	136,827
Kansas	10,954	8,542	29	71	19,596
Kentucky	5,157	8,787	1	--	13,945
Maryland	445	2,313	2,261	12	5,031
Massachusetts	1,136	182	10	168	1,496
Michigan	12,219	13,426	5,476	26	31,147
Missouri	16,462	9,048	1,250	612	27,372
Nebraska	2,372	1,020	1,068	798	5,258
New Jersey	84,396	8,580	3,228	516	96,720
New York	30,662	3,928	5,952	289	40,831
Ohio	11,059	4,302	3,138	1,292	19,791
Pennsylvania	71,840	50,473	9,894	1,702	133,909
Rhode Island	3,427	283	6	--	3,716
Tennessee	3,811	18,527	65	57	22,460
Virginia	378	2,163	1,004	804	4,349
Washington	13,544	1,377	--	--	14,921
West Virginia	11,432	426	--	--	11,858
Wisconsin	4,300	8,597	75	231	13,203
Alabama and Mississippi	5,014	6,912	--	529	12,455
Arkansas and Oklahoma	2,637	3,502	--	--	6,139
Hawaii and Oregon	9,213	6,562	--	--	15,775
Iowa and Minnesota	10,031	14,539	3,575	440	28,585
Louisiana and Texas	173,501	30,803	1,265	356	205,925
Montana and Idaho	697	--	--	--	697
New Hampshire, Maine, Vermont, Delaware	8,694	10,010	532	107	19,343
North and South Carolina	14,836	10,597	1	--	25,434
Utah, Nevada, Arizona	12	788	--	--	800
Total	859,260	373,931	53,503	10,404	1,297,098

[1] Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide and other pigments.

Table 16.—Production and shipments of lead pigments[1] and oxides in the United States

Product	1974				1975			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[2]			Short tons	Value[2]	
			Total	Average per ton			Total	Average per ton
White lead, dry	5,905	5,905	$2,759,668	$467	3,381	3,381	$2,748,194	$813
Red lead	19,880	13,290	7,045,540	530	19,447	15,095	7,618,430	505
Litharge	153,562	161,445	79,390,214	492	133,528	120,475	49,073,653	407
Black oxide	410,716	--	--	--	367,532	--	--	--

[1] Excludes basic lead sulfate; withheld to avoid disclosing individual company confidential data.
[2] At plant, exclusive of container.

Table 17.—Lead content of lead and zinc pigments[1] and lead oxides produced by domestic manufacturers, by source

(Short tons)

Product	1974				1975			
	Lead in pigments produced from—			Total lead in pigments	Lead in pigments produced from—			Total lead in pigments
	Ore		Pig lead		Ore		Pig lead	
	Domestic	Foreign			Domestic	Foreign		
White lead	--	--	4,724	4,724	--	--	2,705	2,705
Red lead	--	--	18,021	18,021	--	--	17,629	17,629
Litharge	--	--	142,813	142,813	--	--	124,181	124,181
Black oxide	--	--	392,421	392,421	--	--	351,171	351,171
Total	--	--	557,979	557,979	--	--	495,686	495,686

[1] Excludes lead in basic lead sulfate and leaded zinc oxide; withheld to avoid disclosing individual company confidential data.

Table 18.—Distribution of white lead (dry and in oil) shipments,[1] by industry

(Short tons)

Industry	1971	1972	1973	1974	1975
Paints	4,396	6,768	3,198	--	--
Ceramics	34	31	18	--	--
Other	2,351	3,267	6,328	5,905	3,381
Total	6,781	10,066	9,544	5,905	3,381

[1] Excludes basic lead sulfate; withheld to avoid disclosing individual company confidential data.

Table 19.—Distribution of red lead shipments, by industry

(Short tons)

Industry	1971	1972	1973	1974	1975
Paints	8,717	4,909	6,509	5,344	4,552
Storage batteries	W	W	W	W	W
Other	12,272	14,864	9,514	7,946	10,543
Total	20,989	19,773	16,023	13,290	15,095

W Withheld to avoid disclosing individual company confidential data; included with "Other."

Table 20.—Distribution of litharge shipments, by industry
(Short tons)

Industry	1971	1972	1973	1974	1975
Ceramics	24,337	23,188	35,910	46,598	33,941
Insecticides	W	W	W	W	W
Oil refining	1,413	1,262	620	765	W
Paints	3,085	7,316	3,112	5,347	3,248
Rubber	2,081	2,162	5,078	6,490	5,850
Other	116,928	113,694	134,424	102,245	77,436
Total	147,844	147,622	179,144	161,445	120,475

W Withheld to avoid disclosing individual company confidential data; included with "Other."

Table 21.—U.S. imports for consumption of lead pigments and compounds

Kind	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
White lead	149	$181	159	$160
Red lead	709	424	448	180
Litharge	8,647	4,392	12,011	4,449
Chrome yellow	4,360	4,237	2,473	2,437
Other lead pigments	99	70	36	60
Other lead compounds	420	697	210	184
Total	14,384	10,001	15,337	7,470

Table 22.—Stocks of lead at primary smelters and refineries in the United States, Dec. 31
(Short tons)

Stocks	1971	1972	1973	1974	1975
Refined pig lead	46,762	60,840	22,018	34,116	76,713
Lead in antimonial lead	5,318	3,626	4,062	3,138	4,560
Lead in base bullion	13,803	11,514	8,845	5,492	6,748
Lead in ore and matte	55,777	69,593	54,922	78,305	68,509
Total	121,660	145,573	89,847	121,051	156,530

Table 23.—Consumer stocks of lead in the United States, Dec. 31, by type of material
(Short tons, lead content)

Year	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
1971	81,934	35,700	6,979	964	125,577
1972	74,161	36,157	6,977	1,249	118,544
1973	84,274	32,226	6,954	667	124,121
1974	106,245	49,504	9,628	1,212	166,589
1975	85,110	41,569	5,059	1,577	133,315

Table 24.—Average monthly and yearly quoted prices of lead [1]

(Cents per pound)

Month	1974		1975	
	U.S. producer	London Metal Exchange	U.S. producer	London Metal Exchange
January	18.98	25.62	24.50	24.38
February	19.00	29.40	24.50	24.55
March	19.53	32.13	24.50	24.62
April	21.49	31.83	24.50	21.73
May	21.50	30.29	23.34	19.11
June	22.90	25.83	19.00	15.99
July	24.50	24.83	19.00	16.27
August	24.50	24.90	19.56	17.38
September	24.50	24.41	20.00	16.33
October	24.50	24.33	20.00	15.62
November	24.50	24.17	20.00	15.27
December	24.50	24.20	19.46	15.10
Average	22.53	26.83	21.53	18.73

[1] Metals Week. Quotations for United States on a nationwide, delivered basis.

Table 25.—U.S. exports of lead, by country [1]

Destination	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Unwrought lead and lead alloys:				
Argentina	--	--	58	$53
Belgium-Luxembourg	13,895	$4,293	4,331	1,693
Brazil	5,674	2,942	3	3
Canada	4,880	2,333	512	155
Chile	81	186	3	30
Colombia	--	--	337	174
Dominican Republic	5	11	88	42
Ecuador	261	228	--	--
Egypt	--	--	111	72
France	259	176	1	1
Germany, West	450	215	124	80
Greece	1	(2)	--	--
Honduras	22	20	3	3
Hong Kong	46	28	--	--
Italy	6,251	3,101	35	17
Jamaica	57	68	43	22
Japan	5,278	2,789	479	193
Korea, Republic of	772	375	169	74
Mexico	1,036	417	136	95
Netherlands	8,364	4,592	10,455	4,867
Paraguay	--	--	64	22
Philippines	385	242	40	33
Singapore	88	40	(2)	(2)
South Africa, Republic of	--	--	111	38
Spain	1,860	932	--	--
Taiwan	99	50	165	197
Thailand	242	147	9	5
Trinidad and Tobago	100	92	5	4
Turkey	661	449	--	--
U.S.S.R	--	--	118	261
United Kingdom	1,918	1,200	87	103
Venezuela	124	17	867	36
Vietnam, South	151	71	--	--
Other	628	334	34	77
Total	53,588	25,348	18,388	8,350
Wrought lead and lead alloys:				
Australia	77	154	11	49
Austria	--	--	23	22
Belgium-Luxembourg	367	437	534	234
Brazil	18	13	143	446
Canada	538	461	866	508
Colombia	31	30	50	57

See footnotes at end of table.

Table 25.—U.S. exports of lead, by country [1]—Continued

Destination	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Wrought lead and lead alloys—Continued				
Costa Rica	138	$85	15	$93
Denmark	11	12	18	23
Dominican Republic	33	47	30	57
Ecuador	69	96	41	55
France	237	177	10	44
Germany, West	98	246	146	206
Honduras	94	70	53	51
Hong Kong	1	3	2	4
Iran	--	--	46	36
Israel	359	218	3	4
Italy	57	52	40	52
Jamaica	13	49	2	15
Japan	305	717	44	109
Korea, Republic of	108	45	10	7
Mexico	688	651	161	348
Netherlands	3,223	1,537	53	79
Panama	77	116	20	56
Philippines	--	--	23	38
Saudi Arabia	46	64	3	13
Sweden	42	48	27	37
Taiwan	100	159	16	74
United Kingdom	546	446	126	268
Venezuela	212	236	186	284
Vietnam, South	863	596	5	77
Other	43	572	161	345
Total	8,394	7,337	2,868	3,691
Scrap:				
Belgium-Luxembourg	1,123	417	1,535	335
Brazil	5,247	1,263	1,744	417
Canada	22,760	4,462	16,798	2,759
Denmark	669	294	1,876	521
Germany, West	4,799	1,414	317	170
Greece	--	--	355	74
Hong Kong	136	62	--	--
Italy	5,197	2,729	128	95
Jamaica	--	--	200	43
Japan	991	370	1,228	328
Korea, Republic of	3,204	838	2,397	316
Malaysia	424	91	--	--
Mexico	1,399	232	2,874	609
Netherlands	2,214	588	5,371	1,006
Pakistan	--	--	40	29
Singapore	--	--	109	14
South Africa, Republic of	1,662	362	2,715	563
Spain	150	72	1	2
Taiwan	2,630	687	4,883	911
Thailand	120	59	446	79
Turkey	811	274	2,403	445
United Kingdom	1,182	639	1,452	627
Venezuela	3,879	1,530	2,974	625
Yugoslavia	648	358	--	--
Other	121	72	105	95
Total	59,366	16,813	49,951	10,063
Grand total	121,348	49,498	71,207	22,104

[1] In addition, foreign lead was reexported as follows: 1974—Unwrought lead and lead alloys, 2,081 tons ($1,413,551); scrap, 84 tons ($28,059); wrought lead and lead alloys, 1 ton ($780) and 1975—Unwrought lead and lead alloys, 213 tons ($12,770); wrought lead and lead alloys, 18 tons ($15,388).

[2] Less than ½ unit.

Table 26.—U.S. exports of lead, by class

Year	Blocks, pigs, anodes, etc.: Unwrought: Quantity (short tons)	Blocks, pigs, anodes, etc.: Unwrought: Value (thousands)	Blocks, pigs, anodes, etc.: Unwrought alloys: Quantity (short tons)	Blocks, pigs, anodes, etc.: Unwrought alloys: Value (thousands)	Wrought lead and lead alloys: Sheets, plates, rods, other forms: Quantity (short tons)	Wrought lead and lead alloys: Sheets, plates, rods, other forms: Value (thousands)	Wrought lead and lead alloys: Foil, powder, flakes: Quantity (short tons)	Wrought lead and lead alloys: Foil, powder, flakes: Value (thousands)	Scrap: Quantity (short tons)	Scrap: Value (thousands)
1973	46,778	$17,538	5,083	$1,964	14,160	$7,010	555	$585	r 59,851	r $12,222
1974	46,030	20,512	7,558	4,836	7,933	6,696	461	641	59,366	16,813
1975	17,455	7,361	933	989	2,695	3,306	173	385	49,951	10,063

r Revised.

Table 27.—U.S. imports[1] of lead, by country

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Ore, flue dust, and residues, n.s.p.f. (lead content):						
Australia	21,728	$5,257	19,341	$6,446	15,916	$4,979
Canada	18,378	3,773	16,035	4,880	28,949	8,618
Colombia	223	54	35	15	112	42
Greenland	--	--	--	--	6,552	2,031
Honduras	20,254	4,229	18,520	7,645	19,153	5,638
Ireland	129	10	34	5	--	--
Japan	21,583	3,885	--	--	--	--
Mexico	1,667	506	10,631	4,186	--	--
Nicaragua	1,934	489	3,493	1,518	1,182	509
Peru	24,033	5,779	26,201	8,536	15,696	5,328
Other	18	1	9	9	--	--
Total	109,947	23,983	94,299	33,240	87,560	27,145
Base bullion (lead content):						
Belgium-Luxembourg	--	--	--	--	19	7
Canada	4	1	831	331	65	31
Mexico	--	--	--	--	378	145
Total	4	1	831	331	462	183
Pigs and bars (lead content):						
Australia	45,550	12,274	3,308	1,537	--	--
Belgium-Luxembourg	27	60	1,338	1,106	2,058	1,141
Canada	61,927	18,950	40,100	18,578	30,688	14,659
China, People's Republic of	--	--	--	--	28	111
Denmark	242	125	198	226	420	450
France	(2)	6	50	54	29	29
Germany:						
East	--	--	81	169	--	--
West	115	236	544	2,845	2,614	1,359
Japan	--	--	2,608	1,850	78	279
Mexico	20,388	5,690	28,504	13,795	29,637	11,400
Netherlands	275	343	354	437	535	701
New Zealand	--	--	--	--	41	21
Peru	42,772	12,948	39,986	14,850	19,876	9,022
Singapore	--	--	59	19	--	--
South Africa, Republic of	5,644	1,718	--	--	--	--
South-West Africa, Territory of	--	--	--	--	1,120	549
Spain	--	--	--	--	119	162
Sweden	43	21	3	10	--	--
Thailand	--	--	144	655	437	1,609
United Kingdom	1,121	561	1,054	1,523	2,638	2,621
Yugoslavia	--	--	--	--	10,181	3,054
Other	13	7	35	37	12	39
Total	178,117	52,939	118,366	57,691	100,511	47,206

See footnotes at end of table.

Table 27.—U.S. imports[1] of lead, by country—Continued

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Reclaimed scrap, etc. (lead content):						
Australia	2,199	$420	105	$42	3,652	$1,429
Bahamas	28	3	--	--	20	4
Canada	183	28	594	336	829	259
Canal Zone	--	--	7	16	--	--
Dominican Republic	18	3	11	5	--	--
Germany, West	--	--	--	--	58	41
Jamaica	--	--	8	7	35	8
Mexico	865	138	271	85	735	224
Netherlands	61	23	--	--	--	--
Panama	13	10	11	3	--	--
United Kingdom	--	--	204	361	35	72
Other	2	(2)	2	1	1	3
Total	3,369	625	1,213	856	5,365	2,040
Grand total	291,437	77,548	214,709	92,118	193,898	76,574

[1] Data are "general imports" that is, they include lead imported for immediate consumption plus material entering the country under bond.
[2] Less than ½ unit.

Table 28.—U.S. imports for consumption[1] of lead, by country

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Ore, flue dust, and residues, n.s.p.f. (lead content):						
Argentina	50	$10	--	--	4	$1
Australia	25,897	5,208	15,156	$3,753	8,407	2,113
Bolivia	583	108	9	9	--	--
Brazil	372	67	--	--	--	--
Canada	12,269	2,336	11,998	2,712	14,878	3,521
Colombia	--	--	--	--	233	56
Honduras	21,780	2,785	15,536	3,536	7,438	2,330
Ireland	129	10	--	--	85	14
Mexico	251	54	6	1	--	--
Nicaragua	424	87	2,518	729	1,381	431
Peru	32,535	6,715	17,468	4,440	12,598	3,863
Other	9	2	--	--	--	--
Total	94,299	17,382	62,691	15,180	45,024	12,329
Base bullion (lead content):						
Belgium-Luxembourg	--	--	--	--	19	7
Canada	4	1	831	331	65	31
Mexico	--	--	--	--	378	145
Total	4	1	831	331	462	183
Pigs and bars (lead content):						
Australia	45,550	12,274	3,308	1,537	--	--
Belgium-Luxembourg	27	60	1,338	1,106	2,058	1,141
Canada	61,927	18,950	40,100	18,578	30,688	14,659
China, People's Republic of	--	--	--	--	28	111
Denmark	242	125	198	226	420	450
France	(2)	6	50	54	29	29
Germany:						
East	--	--	81	169	--	--
West	114	234	545	2,847	2,613	1,357
Japan	--	--	2,608	1,850	78	279
Mexico	20,388	5,690	28,504	13,795	28,728	11,073
Netherlands	275	343	354	437	535	701
New Zealand	--	--	--	--	41	21

See footnotes at end of table.

Table 28.—U.S. imports for consumption[1] of lead, by country—Continued

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Pigs and bars (lead content)—Continued						
Peru	42,772	$12,948	39,986	$14,850	19,876	$9,022
Singapore	--	--	59	19	--	--
South Africa, Republic of	5,644	1,718	--	--	--	--
South-West Africa, Territory of	--	--	--	--	1,120	549
Spain	--	--	--	--	119	162
Sweden	43	21	3	10	--	--
Thailand	--	--	144	655	437	1,609
United Kingdom	1,121	561	1,054	1,523	2,638	2,621
Yugoslavia	--	--	--	--	9,634	2,880
Other	13	7	35	37	12	39
Total	178,116	52,937	118,367	57,693	99,054	46,703
Reclaimed scrap, etc. (lead content):						
Australia	1,699	352	--	--	16	6
Bahamas	28	3	--	--	20	4
Canada	246	40	755	368	921	280
Canal Zone	--	--	7	16	--	--
Dominican Republic	18	3	11	5	--	--
Germany, West	--	--	--	--	58	41
Jamaica	--	--	8	7	35	8
Mexico	r 1,049	157	238	73	655	203
Netherlands	61	23	--	--	--	--
Panama	13	10	11	3	--	--
United Kingdom	--	--	204	361	35	72
Other	2	(2)	2	1	1	3
Total	3,116	588	1,236	834	1,741	617
Sheets, pipe, and shot:						
Belgium-Luxembourg	18	9	--	--	--	--
Canada	7	5	110	71	52	54
Germany, West	(2)	(2)	--	--	21	28
Japan	1	(2)	11	24	--	--
Mexico	734	285	71	39	72	12
Netherlands	12	4	(2)	1	--	--
United Kingdom	--	--	4	3	2	5
Other	--	--	(2)	(2)	--	--
Total	772	303	196	138	147	99
Grand total	276,307	71,211	183,321	74,176	146,428	59,931

r Revised.
[1] Excludes imports for refining, classified as "imports for consumption" by the Bureau of the Census.
[2] Less than ½ unit.

Table 29.—U.S. imports for consumption of lead, by class[1]

(Thousand short tons and thousand dollars)

Year	Ore (lead content) Quantity	Ore (lead content) Value	Base bullion (lead content) Quantity	Base bullion (lead content) Value	Pigs and bars (lead content) Quantity	Pigs and bars (lead content) Value	Sheets, plates, strip, other forms Quantity	Sheets, plates, strip, other forms Value
1973	94	17,382	(2)	1	178	52,937	(2)	18
1974	63	15,180	1	331	118	57,693	(2)	78
1975	45	12,329	(2)	183	99	46,703	(2)	91

Year	Waste and scrap (lead content) Quantity	Waste and scrap (lead content) Value	Dross, skimmings, residues, n.s.p.f. (lead content) Quantity	Dross, skimmings, residues, n.s.p.f. (lead content) Value	Powder and flakes Quantity	Powder and flakes Value	Total value
1973	1	170	2	418	1	285	71,211
1974	1	406	(2)	428	(2)	60	74,176
1975	1	411	(2)	206	(2)	8	59,931

[1] Excludes imports for refining and export, classified as "imports for consumption" by the Bureau of the Census.
[2] Less than ½ unit.

Table 30.—U.S. imports for consumption of miscellaneous products containing lead [1]

Year	Gross weight (short tons)	Lead content (short tons)	Value (thousands)
1973	1,440	533	$4,780
1974	1,643	724	8,730
1975	744	322	3,575

[1] Babbitt metal, solder, white metal, and other lead-containing combinations.

Table 31.—Lead: World mine production, by country
(Short tons)

Country [1]	1973	1974	1975 p
North America:			
Canada	427,441	353,018	e 395,000
Guatemala	112	e 110	e 110
Honduras	r 20,441	20,706	25,643
Mexico [2]	197,640	240,327	197,754
Nicaragua	r 2,984	3,746	1,400
United States [3]	603,024	663,870	621,464
South America:			
Argentina	38,713	38,600	39,700
Bolivia	r 23,144	19,234	15,839
Brazil	r 28,601	28,574	33,000
Chile	282	463	341
Colombia	169	139	e 140
Peru [4]	r 202,178	222,177	225,000
Europe:			
Austria [3]	6,767	6,377	6,725
Bulgaria e	115,700	121,300	123,500
Czechoslovakia e	r 5,200	r 4,300	6,600
Finland	2,346	1,623	1,024
France	26,160	22,916	e 21,300
Germany, East e	7,700	4,400	4,400
Germany, West	38,460	33,811	35,600
Greece	19,596	24,262	14,202
Greenland	6,280	32,342	31,217
Hungary e	2,760	1,760	1,760
Ireland e	61,950	41,560	40,010
Italy	28,550	25,022	29,542
Norway	r 3,676	3,433	3,381
Poland	r 76,600	77,200	79,400
Portugal	r 507	--	--
Romania e	45,200	45,200	45,200
Spain	r 71,127	70,688	63,678
Sweden	83,530	81,192	e 77,700
U.S.S.R. e	520,000	r 525,000	530,000
United Kingdom [5]	r 4,100	4,000	e 3,400
Yugoslavia	131,519	132,085	145,505
Africa:			
Algeria	4,273	3,420	5,290
Congo	r 1,477	1,833	1,300
Kenya	--	e 22	22
Morocco	119,054	95,098	70,100
Nigeria e	380	r 240	240
South Africa, Republic of	1,789	2,741	2,981
South-West Africa, Territory of [6]	68,006	62,568	[7] 53,800
Tunisia	r 17,200	13,800	12,000
Zambia (refined)	r 27,900	27,800	21,400
Asia:			
Burma e	11,570	10,800	11,570
China, People's Republic of e	110,000	110,000	110,000
India	r 7,323	10,083	6,600
Indonesia	e 220	--	--
Iran	r 41,300	52,400	33,100
Japan [8]	58,300	48,775	55,739
Korea, North e	r 100,000	r 110,000	110,000
Korea, Republic of	14,188	11,573	13,406
Philippines	--	1,436	3,735
Thailand	4,083	1,701	1,690
Turkey	r 9,835	5,073	6,610

See footnotes at end of table.

Table 31.—Lead: World mine production, by country—Continued

(Short tons)

Country [1]	1973	1974	1975 p
Oceania:			
Australia	r 444,006	413,701	448,686
New Zealand [9]	362	--	--
Total	r 3,843,723	r 3,832,499	3,787,804

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Uganda and Egypt may produce lead, but available information is inadequate to make reliable estimates of output levels.

[2] Recoverable metal content of lead in concentrates for export plus lead content of domestic products (refined lead, antimonial lead, mixed bars, and other unspecified items).

[3] Recoverable metal.

[4] Recoverable metal; content of lead in concentrates for export plus lead content of domestic smelter products (refined lead, antimonial lead, and bismuth-lead bars).

[5] May include small quantities of zinc.

[6] Data compiled from operating company reports of Tsumeb Corp. Ltd., South West Africa Co. Ltd., and South African Iron and Steel Industrial Corp. Ltd. (ISCOR) for Imcor Zinc (Pty.) Ltd's Rosh Pinah mine. Data from Tsumeb Corp. Ltd. are for calendar years; data from other companies are for fiscal years ending June 30 of the year stated.

[7] Figure comprises reported production of South West Africa Co. Ltd. and Rosh Pinah mine plus an estimate for Tsumeb Corp. Ltd.

[8] Content of concentrates.

[9] Contained in lead-copper concentrate.

Table 32.—Lead: World smelter production,[1] by country

(Short tons)

Country	1973	1974	1975 p
North America:			
Canada (refined)	206,012	139,380	e 190,000
Guatemala [2]	72	250	248
Mexico (refined)	190,621	220,660	196,200
United States (refined) [3]	r 674,516	673,024	636,122
South America:			
Argentina	r 35,500	38,600	43,700
Bolivia (refined, including solder)	e 20	23	--
Brazil	r 42,329	45,951	e 46,000
Peru (refined)	r 91,787	88,798	77,300
Europe:			
Austria [4]	10,927	9,705	10,320
Belgium [2]	r 125,319	120,822	127,352
Bulgaria e [2]	r 118,000	r 124,000	126,000
Czechoslovakia [2]	18,435	19,698	e 19,800
France	183,633	174,794	149,233
Germany, East e	22,000	22,000	22,000
Germany, West	r 94,584	128,011	101,679
Greece (refined) [4]	r 26,500	16,100	14,100
Hungary e [2]	8,800	14,880	14,880
Italy	38,721	47,906	36,593
Netherlands [2]	27,840	29,112	26,389
Poland (refined) [2]	r 75,400	78,900	84,000
Portugal (refined)	r 1,225	1,310	1,320
Romania e	43,000	43,000	43,000
Spain	96,256	87,666	80,853
Sweden (refined)	51,403	49,808	e 45,300
U.S.S.R. (primary) e	520,000	525,000	530,000
United Kingdom [5]	33,407	32,386	28,328
Yugoslavia (refined) [2]	124,155	130,544	e 165,000
Africa:			
South-West Africa, Territory of (refined)	70,098	70,925	48,800
Tunisia	28,619	29,102	25,790
Zambia (refined)	27,574	27,112	21,032
Asia:			
Burma	11,162	10,246	10,974
China, People's Republic of e	110,000	110,000	110,000
India	r 2,906	4,394	5,257
Iran e	([6])	r 330	440
Japan (refined)	r 251,366	251,283	214,087
Korea, North e	90,000	110,000	110,000
Korea, Republic of	4,823	4,881	6,600
Turkey	r 6,060	6,170	2,420
Oceania: Australia (refined and bullion)	r 374,794	371,434	342,574
Total	r 3,837,864	3,858,205	3,713,691

e Estimate. p Preliminary. r Revised.

[1] Primary except as noted, or where source does not differentiate.

[2] Includes recovery from secondary materials.

[3] Refined from domestic and foreign ores; excludes lead refined from imported base bullion.

[4] Includes primary lead content of antimonial lead.

[5] Lead bullion from imported ores and concentrates.

[6] Revised to none.

Lime

Avery H. Reed [1]

Lime output in 1975, including that for Puerto Rico, declined 11% to 19.2 million tons. Total value established a new annual record, increasing 10% to $526 million.

Output of all types of lime decreased. Chemical and industrial lime was down 10%, construction lime 12%, refractory dolomite 28%, and agricultural lime 11%.

Table 1.—Salient lime statistics in the United States [1]
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
Number of plants	187	185	175	172	171
Sold or used by producers:					
Quicklime	15,138	16,611	17,230	17,795	15,875
Hydrated lime	3,446	2,604	2,610	2,533	2,344
Dead-burned dolomite	1,007	1,075	1,250	1,278	914
Total	19,591	20,290	21,090	21,606	19,133
Value [2]	$308,100	$339,304	$365,849	$473,685	$523,805
Average value per ton	$15.73	$16.72	$17.35	$21.92	$27.38
Lime sold	12,337	13,353	14,394	14,640	12,840
Lime used	7,254	6,937	6,696	6,966	6,292
Exports [3]	66	38	37	32	54
Imports for consumption [3]	242	248	334	416	259

[1] Excludes regenerated lime. Excludes Puerto Rico.
[2] Selling value, f.o.b. plant, excluding cost of containers.
[3] Bureau of the Census.

DOMESTIC PRODUCTION

Lime producers sold or used 19.2 million tons, compared with 21.6 million tons in 1974. Sales of lime decreased 12% to 12.9 million tons. Captive lime used by producers declined 10% to 6.3 million tons.

Output of quicklime decreased 12% to 16.8 million tons. Production of hydrated lime decreased 8% to 2.4 million tons. Output of dead-burned dolomite declined 28% and was 62% below the 1956 record high level. The number of plants decreased from 173 to 172 and the average output per plant decreased from 125,100 to 111,400 tons per year.

Eight States—Ohio, Pennsylvania, Texas, Missouri, Michigan, Indiana, Alabama, and Illinois—accounted for 68% of the total output. Production declined 4% in Indiana, 5% in Texas, 6% in Michigan, 7% in Pennsylvania and Alabama, 15% in Illinois, 16% in Missouri, and 17% in Ohio.

[1] Supervisory physical scientist, Division of Nonmetallic Minerals.

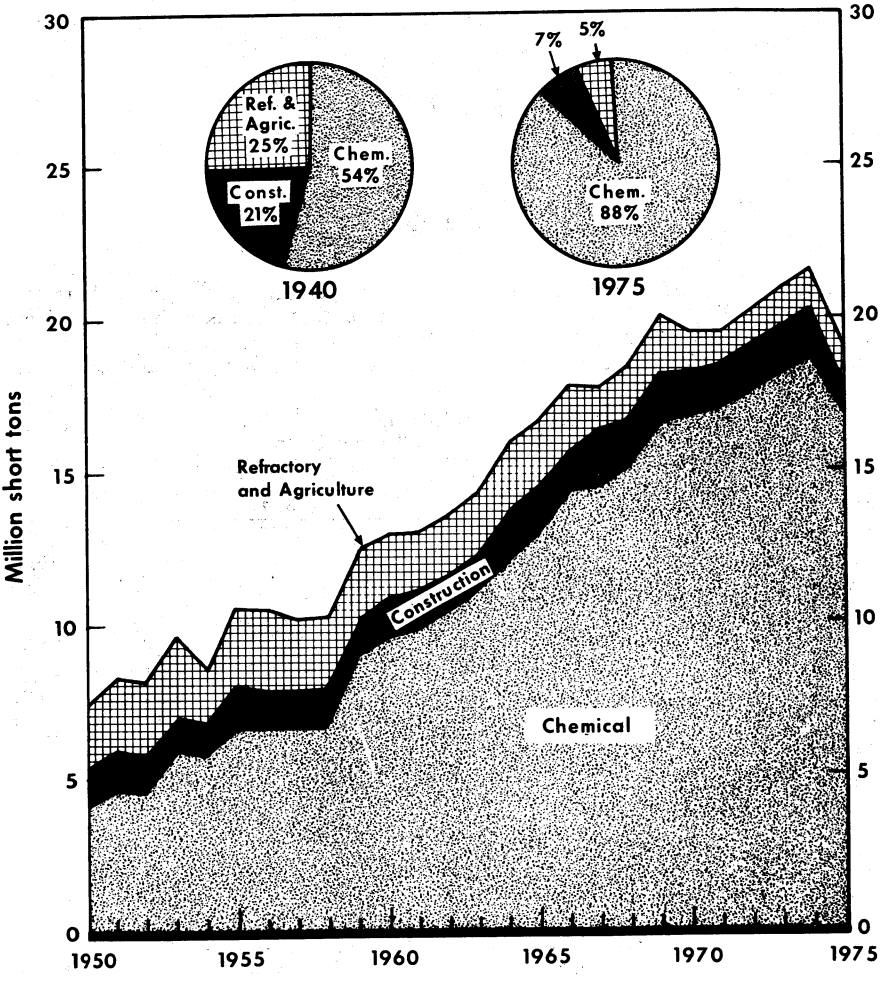

Figure 1.—Trends in major uses of lime.

Table 2.—Lime sold or used by producers in the United States, by State and kind [1]
(Thousand short tons and thousand dollars)

State	1974					1975				
	Plants	Hydrated	Quicklime	Total [2]	Value	Plants	Hydrated	Quicklime	Total [2]	Value
Alabama	5	128	925	1,054	22,346	5	128	857	985	29,404
Arizona	8	W	W	422	9,071	7	W	W	512	12,444
Arkansas	3	W	W	187	3,189	3	W	W	170	3,848
California	15	62	537	600	14,877	15	57	538	595	18,626
Colorado	11	W	W	198	3,815	11	W	W	198	4,577
Connecticut	1	17	16	33	1,148	1	14	9	23	1,013
Florida	3	W	W	185	5,315	3	W	W	199	7,708
Hawaii	2	W	W	6	221	2	W	W	6	250
Kansas	1	--	28	28	535	1	--	W	W	W
Louisiana	4	W	W	796	17,665	4	W	W	485	12,484
Maryland	1	6	17	23	527	1	5	10	15	434
Massachusetts	2	25	145	170	4,972	2	20	132	152	5,215
Michigan	9	--	1,528	1,528	30,036	9	--	1,434	1,434	36,540
Mississippi	1	--	70	70	1,393	1	--	53	53	1,060
Missouri	3	W	W	1,901	36,369	3	W	W	1,606	40,630
Montana	3	--	226	226	3,364	3	--	221	221	5,188
Nebraska	4	--	36	36	591	4	--	W	W	W
New Mexico	2	--	58	58	1,679	2	--	W	W	W
Ohio	17	196	3,975	4,171	93,695	17	177	3,305	3,482	95,136
Oregon	3	W	W	98	2,818	3	W	W	96	3,281
Pennsylvania	10	405	1,675	2,080	50,147	10	336	1,605	1,940	60,047
Puerto Rico	1	39	--	39	2,923	1	27	1	28	2,231
South Dakota	1	46	47	94	2,059	1	W	W	W	W
Tennessee	3	W	W	136	3,449	3	W	W	106	3,735
Texas	13	713	1,122	1,835	39,644	13	695	1,040	1,735	46,179
Utah	5	W	W	176	4,911	5	W	W	161	4,540
Virginia	6	63	832	895	18,929	6	38	667	705	20,192
West Virginia	2	W	W	128	2,315	2	W	W	W	W
Wisconsin	5	121	190	311	6,764	5	109	187	296	8,604
Wyoming	3	--	29	29	464	3	--	W	W	W
Other States [3]	26	751	7,617	4,132	91,377	26	765	6,730	3,957	102,670
Total	173	2,572	19,073	21,645	476,608	172	2,371	16,789	[2] 19,159	526,036

W Withheld to avoid disclosing individual company confidential data; included in "Other States."
[1] Excludes regenerated lime. Includes Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes Idaho, Illinois, Indiana, Iowa, Kentucky, Minnesota, Nevada, New York, North Dakota, Oklahoma, Washington, States indicated by symbol W, and exports.

Leading producing companies were Marblehead Lime Co. with two plants in Illinois and one each in Indiana, Michigan, and Pennsylvania; Mississippi Lime Co. in Missouri; Bethlehem Steel Corp. with two plants in Pennsylvania and one in New York; Allied Chemical Corp. in Louisiana and New York; Martin-Marietta Chemicals in Alabama and Ohio; The Dow Chemical Co. in Michigan and Texas; The Flintkote Co. with two plants in California, two in Nevada, and one each in Arizona, Utah, and Virginia; United States Gypsum Co. in Louisiana, Ohio, and Texas; United States Steel Corp. in Ohio; and Diamond Shamrock Corp. in Ohio. These 10 companies, operating 27 plants, accounted for 40% of the total lime production.

The five largest lime plants, each producing more than 400,000 tons, accounted for 18% of the total lime output. Thirty-three plants produced more than 200,000 tons and accounted for 60% of the total.

Leading individual plants were Mississippi Lime's Ste. Genevieve plant, Marblehead's Buffiington plant, Allied Chemical's Syracuse plant, U.S. Steel's Lorain plant, and Diamond Shamrock's Plainsville plant.

Table 3.—Lime sold or used by producers in the United States, by size of plant [1]
(Thousand short tons)

Size of plant	1974			1975		
	Plants	Quantity	Percent of total	Plants	Quantity	Percent of total
Less than 10,000 tons	28	173	1	29	187	1
10,000 to 25,000 tons	35	635	3	31	556	3
25,000 to 50,000 tons	18	626	3	23	749	4
50,000 to 100,000 tons	28	2,018	9	28	1,968	10
100,000 to 200,000 tons	22	3,161	15	28	4,136	22
200,000 to 400,000 tons	33	9,193	42	28	8,024	42
More than 400,000 tons	9	5,839	27	5	3,540	18
Total	173	21,645	100	172	[2] 19,159	100

[1] Excludes regenerated lime. Includes Puerto Rico.
[2] Data do not add to total shown because of independent rounding.

CONSUMPTION AND USES

Lime was consumed in every State. Leading consuming States were Ohio, Pennsylvania, Michigan, Indiana, and Texas, each of which consumed more than 1 million tons. These five States accounted for 53% of the total lime consumed.

Leading quicklime-consuming States were Ohio, Michigan, Indiana, Pennsylvania, and Texas, each of which consumed more than 1 million tons. These five States accounted for 53% of the total quicklime consumed.

Leading hydrate-consuming States were Texas, Pennsylvania, Illinois, Ohio, and Louisiana, each of which consumed more than 100,000 tons. These five States accounted for 56% of the total hydrate consumed.

Lime sold by producers was used for chemicals, 83%; construction, 10%; refractories, 6%; and agriculture, 1%. Captive lime used by producers was 33% of the total, compared with 32% in 1974. Captive lime was used mainly for alkalies, 33%; BOF steel furnaces, 24%; and sugar refining, 13%.

Leading individual uses were BOF steel furnaces, alkalies, water purification, paper and pulp, sugar refining, and refractories, which together accounted for 67% of the total consumption.

Of the main chemical and industrial uses, lime for BOF steel furnaces was produced principally in Ohio (26%), Indiana (16%), Pennsylvania (15%), and Illinois (10%). Lime for alkalies was produced mainly in New York, Michigan, Ohio, and Texas. Lime for water purification was produced mainly in Missouri (29%), Pennsylvania (15%), Texas (9%), and Alabama (8%). Lime used for paper and pulp, excluding regenerated lime, was produced mainly in Alabama (33%), Wisconsin (11%), Texas (11%), and Virginia (11%). Lime for refining sugar was produced mainly in California (23%), Idaho (11%), and Colorado (11%).

Table 4.—Destination of shipments of lime sold or used by producers in the United States in 1975, by State [1]

(Short tons)

State	Quicklime	Hydrated lime	Total
Alabama	489,813	60,193	550,006
Arizona	479,307	1,744	481,051
Arkansas	138,745	18,544	157,289
California	743,246	70,647	813,893
Colorado	202,095	5,340	207,435
Connecticut	42,021	10,016	52,037
Delaware	16,236	7,033	23,269
District of Columbia	350	497	847
Florida	329,288	51,639	380,927
Georgia	132,579	24,243	156,822
Hawaii	1,331	4,335	5,666
Idaho	101,002	5,670	106,672
Illinois	734,002	143,112	877,114
Indiana	1,736,485	67,810	1,804,295
Iowa	54,249	20,015	74,264
Kansas	68,586	27,205	95,791
Kentucky	263,893	16,818	280,711
Louisiana	371,331	106,423	477,754
Maine	20,820	751	21,571
Maryland	393,554	18,531	412,085
Massachusetts	30,248	14,468	44,716
Michigan	1,782,322	42,623	1,824,945
Minnesota	135,629	15,434	151,063
Mississippi	118,255	18,458	136,713
Missouri	160,493	33,647	194,140
Montana	222,304	2,796	225,100
Nebraska	60,337	8,492	68,829
Nevada	34,529	6,075	40,604
New Hampshire	7,083	641	7,724
New Jersey	57,030	56,283	113,313
New Mexico	83,151	7,105	90,256
New York	872,390	36,359	908,749
North Carolina	110,220	26,624	136,844
North Dakota	61,157	15,476	76,633
Ohio	2,643,492	118,163	2,761,655
Oklahoma	116,850	19,118	135,968
Oregon	97,640	30,038	127,678
Pennsylvania	1,734,796	246,691	1,981,487
Puerto Rico	287	29,927	30,214
Rhode Island	5,971	1,861	7,832
South Carolina	74,911	8,027	82,938
South Dakota	9,053	15,055	24,108
Tennessee	127,818	70,660	198,478
Texas	1,064,921	709,500	1,774,421
Utah	85,622	9,834	95,456
Virginia	132,640	20,653	153,293
Washington	124,275	50,077	174,352
West Virginia	343,535	19,924	363,459
Wisconsin	107,969	47,587	155,556
Wyoming	28,241	5,780	34,021
Other States [2]	125	5,262	5,387
Total United States	16,752,227	2,353,204	19,105,431
Exports:			
Canada	19,764	14,512	34,276
Other countries	16,641	2,936	19,577
Total exports	36,405	17,448	53,853
Grand total	16,788,632	2,370,652	19,159,284

[1] Excludes regenerated lime. Includes Puerto Rico.
[2] Includes Alaska, Vermont, and the Virgin Islands.

Table 5.—Lime sold or used by producers in the United States, by use [1]
(Thousand short tons and thousand dollars)

Use	1974				1975			
	Sold	Used	Total [2]	Value	Sold	Used	Total [2]	Value
Agriculture	109	--	109	3,104	97	--	97	3,371
Construction:								
Soil stabilization	W	W	797	20,202	749	1	750	21,165
Mason's lime	W	W	376	9,520	282	1	283	7,970
Finishing lime	225	--	225	5,700	196	--	196	5,520
Other construction uses	W	W	64	1,620	28	34	61	1,720
Total [2]	1,405	58	1,463	37,042	1,255	36	1,291	36,375
Chemical and industrial:								
Steel BOF	5,669	1,658	7,327	158,000	5,024	1,518	6,542	177,000
Alkalies	W	W	2,589	55,700	7	2,093	2,100	56,700
Water purification	W	W	1,361	29,300	1,394	9	1,403	37,900
Paper and pulp	W	W	1,064	22,900	819	102	921	24,900
Sugar refining	67	707	774	16,700	77	837	914	24,700
Copper ore concentration	280	431	711	15,300	327	356	683	18,400
Sewage treatment	535	31	567	12,200	611	70	681	18,400
Steel, electric	724	81	805	17,300	583	79	663	17,900
Steel, open-hearth	W	W	663	14,300	467	44	511	13,800
Aluminum and bauxite	W	W	384	8,260	140	154	294	7,940
Glass	308	--	308	6,630	261	--	261	7,050
Calcium carbide	W	W	263	5,660	113	92	205	5,530
Precipitated calcium carbonate	W	--	W	W	40	25	65	1,750
Petrochemicals	97	--	97	2,090	64	--	64	1,730
Food products	W	W	72	1,550	29	34	63	1,700
Metallurgy, other	W	W	50	1,080	52	2	53	1,430
Acid mine water	W	W	84	1,810	49	1	50	1,350
Oil well drilling	16	--	16	344	41	--	41	1,110
Petroleum refining	61	--	61	1,310	30	--	30	810
Tanning	24	--	24	516	26	--	26	702
Plastics	W	--	W	W	25	--	25	675
Magnesium metal	W	W	23	494	8	13	21	567
Insecticides	7	--	7	151	10	--	10	270
Ore concentration, other	8	--	8	172	7	--	7	190
Fertilizer	8	--	8	172	7	--	7	190
Paint	3	--	3	65	4	--	4	108
Rubber	5	--	5	108	3	--	3	80
Sulfur removal	4	--	4	86	3	--	3	80
Sand-lime brick	4	--	4	86	W	--	W	W
Wire drawing	W	W	3	65	1	1	2	50
Silica brick	14	--	14	301	W	--	W	W
Other uses [3]	4,136	3,917	1,497	31,734	444	762	1,206	32,086
Total	11,970	6,825	18,796	404,384	10,666	6,192	16,858	455,098
Refractory dolomite	1,195	82	1,278	32,078	849	64	914	31,193
Grand total [2]	14,679	6,966	21,645	476,608	12,868	6,292	19,159	526,036

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Excludes regenerated lime. Includes Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes magnesia from sea water, magnesite, chrome, lithium, explosives, adhesives, coke, other uses, and uses indicated by symbol W.

PRICES

The average value of lime sold or used by producers in 1975 was $27.46 per ton, an increase of 25% over the 1974 price of $22.02 and an increase of 58% over the 1973 price of $17.42.

Values ranged from $27.00 for chemical and industrial lime to $28.18 for construction lime, $34.13 for refractory dolomite, and $34.75 for lime used in agriculture.

Values for quicklime sold ranged from $27.69 for chemical lime to $30.43 for construction lime, $31.30 for lime used in agriculture, and $33.46 for dead-burned dolomite, and averaged $28.20, an increase of 33% over the 1974 value.

Values for hydrated lime ranged from $27.66 for construction lime to $31.10 for chemical lime, and $36.50 for lime used in agriculture, and averaged $29.52, an increase of 15% over the 1974 price.

FOREIGN TRADE

Exports of lime increased 70% to 53,900 tons but were 22% below the 1968 record. Of the total exports, Canada received 85% and Mexico 8%. The remaining 7% went to 29 countries, listed in order of shipments as follows: The Republic of South Africa, Panama, Trinidad, the Bahamas, Burmuda, the Philippines, West Germany, the United Arab Emirates, Surinam, the United Kingdom, Jamaica, Venezuela, Honduras, Ireland, Colombia, Brazil, Australia, Indonesia, Austria, the Netherlands Antilles, Peru, Bahrain, Argentina, Iran, the Dominican Republic, New Zealand, Singapore, Italy, and Tanzania.

Imports of lime declined 38% to 259,000 tons. Imports were mainly from Canada.

Table 6.—U.S. exports of lime

Year	Quantity (short tons)	Value (thousands)
1973	36,914	$1,208
1974	31,639	1,516
1975	53,853	2,746

Table 7.—U.S. imports for consumption of lime

	Hydrated lime		Other lime		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	47,309	$941	286,703	$4,302	334,012	$5,243
1974	48,284	1,311	367,917	6,368	416,201	7,679
1975	44,637	1,392	214,311	4,867	258,948	6,259

WORLD REVIEW

Lime is produced all over the world, mainly in the heavily industralized areas. Source materials are adequate. The United States, with 17% of the total, ranks second in world production.

Canada.—During 1974 there were 24 active lime plants in Canada; 10 in Ontario, 4 in Quebec, 4 in Alberta, 3 in Manitoba, 2 in British Columbia, and 1 in New Brunswick. Of the 85 kilns in operation, 54 were vertical, 27 were rotary, 3 were rotary grate, and 1 was vibratory grate. Total lime output was 1.9 million tons, of which 426,000 tons were exported, mainly to the United States.

Germany, West.—West Germany ranked third in world lime output, with 9% of production. Output was 10.1 million tons.

Japan.—Japan produced 9% of world lime output, and ranked fourth among world producers with 10.1 million tons.

Poland.—Poland produced 8% of the world's lime and ranked fifth among producing countries with 8.8 million tons.

U.S.S.R.—The Soviet Union was the leading lime-producing country in the world, with 21% of the total. Output was estimated at 24 million tons.

Yugoslavia.—Construction started on a new 70,000-ton lime plant at Jelen Do, near Cacak, Serbia. Two new lime plants were completed near Kucevo, Serbia. Construction continued on a new 100,000-ton lime plant near Drnis, Croatia. Plans were made to construct a 120,000-ton lime plant near Slavonski Brod, Croatia.

Table 8.—Quicklime and hydrated lime, including dead-burned dolomite: World production by country
(Thousand short tons)

Country [1]	1973	1974	1975 p
North America:			
Canada	1,891	2,009	1,889
Costa Rica	14	24	17
Guatamala	e 25	62	39
Jamaica	240	836	202
Nicaragua e	100	43	51
Puerto Rico	42	39	28
United States (sold or used by producers)	21,090	21,606	19,133
South America:			
Brazil e	2,200	2,200	2,200
Chile	NA	2,862	e 2,870
Colombia e	1,100	1,100	1,100
Paraguay	28	30	31
Peru	63	r e 70	e 70
Uruguay	53	51	51
Europe:			
Austria	874	1,145	1,044
Belgium	3,770	3,904	e 3,850
Bulgaria	r 1,013	1,446	e 1,430
Czechoslovakia	r 2,903	3,073	e 3,100
Denmark	239	188	183
Finland e	330	360	385
France	r 5,530	5,625	5,003
Germany, East	3,339	3,337	3,400
Germany, West	12,386	12,358	10,114
Hungary	737	701	e 700
Ireland	84	87	86
Italy	2,478	2,557	2,410
Malta	35	e 33	e 33
Norway	r 130	127	e 110
Poland [2]	r 8,458	8,772	8,818
Portugal	r 288	238	e 235
Romania	r 2,896	3,381	e 3,300
Spain	377	r e 380	e 380
Sweden	933	977	e 990
Switzerland	152	125	e 120
U.S.S.R. e	24,000	24,000	24,000
Yugoslavia	2,061	2,248	e 2,400
Africa:			
Algeria	40	r e 40	e 40
Burundi e	(3)	(3)	(3)
Egypt	90	e 90	e 90
Ethiopia [4]	9	6	e 6
Kenya	35	e 35	e 35
Libya	NA	22	e 22
Mauritius	e 8	4	8
Malawi e	(3)	(3)	(3)
Mozambique	11	6	e 2
South Africa, Republic of (sales)	r 1,459	1,322	1,464
Tanzania	7	6	8
Tunisia	r 198	126	e 130
Uganda e	33	33	33
Zaire e	165	165	165
Zambia e	120	120	120
Asia:			
Cyprus	93	67	25
India e	375	375	375
Iran e	1,100	1,100	1,100
Israel	e 200	220	265
Japan	13,024	12,362	10,110
Jordan	3	3	3
Korea, Republic of e	r 100	r 105	110
Kuwait	(3)	(3)	(3)
Lebanon	168	195	NA
Mongolia e	45	45	45
Nepal	--	(3)	60
Philippines	166	111	40
Saudi Arabia e	17	17	17
Taiwan	194	171	161
Oceania:			
Australia [5]	929	r e 940	e 940
Fiji Islands	3	3	e 3
Total	r 118,451	123,183	115,149

e Estimate. p Preliminary. r Revised. NA Not available.
[1] Lime is produced in many other countries besides those listed. Mexico, Venezuela, and the United Kingdom are among the more important countries for which official data are unavailable.
[2] Excludes output by small producers.
[3] Less than ½ unit.
[4] Figure for 1973 includes production in Eritrea.
[5] Year ending June 30 of that stated.

Lithium

By Richard H. Singleton [1]

Total deliveries [2] of lithium minerals [3] in the United States decreased approximately 20% in 1975 to about 4,400 tons of lithium equivalent because of an increase in producers' inventories, and because smaller quantities were released from the Government stockpile. Apparent consumption also decreased by about 20% to approximately 3,500 tons mainly because of decreased demand for lithium carbonate in the aluminum and ceramic industries. Demand for lithium hydroxide monohydrate reportedly remained strong. The United States continued to produce and consume over one-half of the world's lithium supply. Approximately 20% of the U.S. supply continued to be exported to Western Europe and Japan; two-thirds in the form of lithium carbonate with the balance being mainly lithium hydroxide monohydrate.

The United States imported about 4,600 tons of mineral concentrate from Brazil, nearly twice that imported in 1974. Total imports of lithium chemicals by Western Europe increased 13% to approximately 700 tons of lithium equivalent. The share of these imports coming from the United States increased to 86%.

Japanese imports of lithium chemicals decreased by 65% to 237 tons of lithium equivalent reflecting a sharply decreased demand coupled with a reduction of users' inventories during 1975. Total exports of lithium chemicals by the U.S.S.R. to Western Europe and Japan decreased 62% to about 170 tons of lithium equivalent.

Legislation and Government Programs.—The General Services Administration (GSA) sold 371 short tons of lithium hydroxide monohydrate during 1975. At yearend, 2,547 tons of lithium hydroxide monohydrate was available for sale by GSA under the Federal Property Act.

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Deliveries are herein defined as production plus imports minus producers' inventory change.
[3] Spodumene and petalite concentrate. Also includes lithium carbonate from California and Nevada brines.

Table 1.—Salient statistics on lithium minerals [1]
(Short tons of contained lithium)

	1971	1972	1973	1974	1975
United States:					
Production	W	W	W	W	W
Imports	130	30	130	70	90
Producer stocks	W	W	W	W	W
Shipments of government stockpile excesses	--	--	160	430	61
Deliveries	3,800	3,920	4,770	5,550	4,440
Exports [e] [2]	650	640	920	[r] 1,000	900
Apparent consumption	3,150	3,280	3,850	[r] 4,550	3,540
Rest of world: Production [e]	1,900	2,000	2,400	2,500	2,300
Total world: Supply [e]	5,600	5,900	7,000	8,000	6,600

[e] Estimate. [r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes lithium carbonate produced in Nevada.
[2] Includes lithium compounds.

DOMESTIC PRODUCTION

The two major lithium producers, Foote Mineral Co. and Lithium Corp. of America (Lithcoa) continued to mine and beneficiate spodumene from pegmatite dikes in North Carolina. Foote, 92%-owned by Newmont Mining Corp., continued as the major domestic producer of spodumene concentrate. Construction continued on its 6,000-ton-per-year lithium carbonate plant in North Carolina, scheduled for completion in 1976. Foote continued to produce lithium carbonate from subsurface brines at Silver Peak, Nev. Kerr-McGee Corp. continued to produce small quantities of lithium carbonate from Searles Lake brines in California.

Lithcoa remained the major producer of lithium chemicals, excluding lithium carbonate, at its North Carolina works near its mine. Beneficiation capacity for producing spodumene concentrate was increased 20% in 1975. Lithcoa also increased its lithium hydroxide production capacity by 20%.

CONSUMPTION AND USES

Apparent domestic consumption in 1975 decreased 20%, compared with 1974, although consumption continued to increase during the first calendar quarter. Lithium carbonate sales were down because of reduced demand in the aluminum and ceramic and glass industries, which were the major consumers of lithium products.

Reduced demand in the aluminum industry was primarily due to lowered production of primary aluminum; interest in this use of lithium remained high, and several major world aluminum producers initiated potline tests in 1975. Aluminum Co. of America at Palestine, Tex., began operation in 1975 of a 15,000-ton-per-year aluminum potline using a new type of reduction cell based on the electrolysis of aluminum chloride and using lithium chloride as a component of the electrolyte.

Demand was down in 1975 for lithium fluoride, used principally in the ceramics industry, and for lithium chloride, used in welding and dehumidification. Demand for lithium bromide, used in air conditioning, decreased less than that for the other two halides. Demand for lithium in grease, synthetic rubber, and vitamin A manufacture held steady at about the same level as in 1974. Demand for lithium hydroxide increased.

PRICES

The domestic price of ceramic-grade spodumene concentrate remained steady throughout 1975 at $123.50 per ton as reported in Ceramic Industry. The domestic price of lithium carbonate powder delivered, bagged, and in carload lots remained steady at 79.5 cents per pound during 1975 as reported in Chemical Marketing Reporter. Prices of both the hydroxide and the metal held steady during the first half of 1975. The price of lithium hydroxide monohydrate delivered in drums, carload lots, increased 35% to $1.18 per pound at yearend. The price of lithium metal delivered in lots of 1,000-pounds minimum rose 18% to $11.10 per pound at yearend.

FOREIGN TRADE

U.S. exports of lithium chemicals are not completely reported in available trade statistics, with some of the compounds included inseparably with other nonlithium-bearing compounds. However, review of data on imports of lithium compounds from the United States by other countries indicates that, in terms of lithium content, exports decreased by approximately 10%; lithium carbonate accounted for about two-thirds of these exports in 1975, the remainder being largely lithium hydroxide. Japan, West Germany, and France received 90% of apparent U.S. exports of

Table 2.—Lithium metal and chemicals: Apparent U.S. exports [1] to selected countries

(Short tons)

Commodity	Belgium-Luxembourg	France	Germany, West	Italy	Japan	Netherlands	Spain	Total	Total lithium content
1974									
Gross weight:									
Lithium carbonate	r 22	r 183	1,475	25	1,480	NA	65	r 3,250	r 610
Lithium hydroxide [2]	r 45	r 263	249	67	412	NA	104	r 1,140	r 189
Lithium chloride	NA	NA	19	NA	(3)	NA	--	19	3
Lithium bromide	NA	NA	NA	NA	[4] 163	NA	NA	[4] 163	13
Lithium metal	--	r 2	6	--	18	--	--	r 26	r 26
Lithium content (total)	12	r 80	327	16	377	NA	29	r 841	r 841
1975									
Gross weight:									
Lithium carbonate	NA	121	1,968	74	495	NA	26	2,684	505
Lithium hydroxide [5]	49	332	279	71	385	117	116	1,349	223
Lithium chloride	NA	NA	29	NA	1	NA	--	30	5
Lithium bromide	NA	NA	NA	NA	[4] 3	NA	NA	[4] 3	(3)
Lithium metal	NA	--	23	NA	7	--	--	30	30
Lithium content (total)	8	78	444	26	164	19	24	763	763

r Revised. NA Not available.

[1] Only in the case of lithium hydroxide are U.S. exports of lithium chemicals reported separately in official U.S. trade statistics. Other lithium compounds as well as lithium metal are reported in basket categories. Data in this table are derived from import statistics of the listed major trading partner countries.

[2] Officially recorded U.S. exports totaled 599 short tons, distributed as follows: Argentina—5, Belgium-Luxembourg—2, Bolivia—2, Brazil—2, Canada—23, France—124, West Germany—55, India—2, Indonesia—6, Italy—20, Japan—181, the Republic of Korea—1, Mexico—21, the Netherlands—56, Romania—5, Spain—36, Sweden—less than ½ unit, and the United Kingdom—58.

[3] Less than ½ unit.

[4] Figure represents estimated gross weight of lithium bromide included in a basket category of lithium bromide plus potassium bromide (50% of total reported lithium bromide and potassium bromide is assumed to be lithium bromide).

[5] Officially recorded U.S. exports total 613 short tons, distributed as follows: Belgium-Luxembourg—15, Bolivia—12, Brazil—2, Canada—25, Chile—9, France—142, West Germany—33, India—29, Indonesia—42, Iran—2, Ireland—2, Japan—117, Mexico—54, the Netherlands—49, Pakistan—3, Philippines—2, the Republic of South Africa—11, Spain—11, Sweden—5, Switzerland—8, Thailand—5, and the United Kingdom—35.

lithium products. Apparent exports to Japan decreased 56%. Apparent exports to West Germany increased 36%. Approximately 600 tons of spodumene concentrate, equal to about 22 tons of lithium equivalent, was shipped to West Germany, France, and the Netherlands, a decrease of 83% from 1974, according to recipient-country import data.

Imports of lithium-mineral concentrate were 44% above the 1974 level at 4,548 tons, containing about 80 tons of lithium. Brazil supplied all of these imports primarily as hand-picked petalite for use in low-expansion ceramicware.

Table 3.—U.S. imports for consumption of lithium concentrate

Customs district and country of origin	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Baltimore district: Brazil	2,379	$217	4,548	$538
Buffalo: Canada	786	106	--	--
Total	3,165	323	4,548	538

WORLD REVIEW

Canada.—Construction of a commercial mine and plant at Bernic Lake in Manitoba for producing lithium carbonate, announced in 1974 for completion in 1977, had not begun by the end of 1975, and $20 million in investment capital was being sought by the potential producer, Tantalum Mining Corp. of Canada, Ltd. However, construction of a pilot plant at Bernic Lake for production of lithium carbonate began. The plant reportedly will process 100 tons of spodumene ore per day. Scattered prospecting for lithium minerals continued in Ontario. No exports of lithium minerals from Canada were apparent.

Chile.—Preliminary exploration aided by the U.S. Geological Survey indicated the presence of more than 1 million tons of lithium equivalent in the subsurface potassic brines in Salar de Atacama. The reported lithium concentration is greater than 0.1%, and commercial exploitation appeared feasible. The Salar de Uyuni in neighboring Bolivia appeared favorable geologically for similar accumulation of large amounts of lithium-rich brines.

France.—Imports of lithium chemicals decreased 15% to 158 tons of lithium equivalent. Imports of lithium mineral concentrate decreased about 71% to about 40 tons of lithium equivalent.

Germany, West.—Imports of lithium chemicals into West Germany, Europe's largest producer of secondary lithium salts, increased 15% to about 550 tons of lithium equivalent, mainly because of increased receipts of lithium carbonate from the United States. Imports of lithium mineral concentrate decreased 17% to about 90 tons of lithium equivalent. Approximately 30% of these imports were reexported after chemical processing mainly to other countries in West Europe.

Japan.—Imports of lithium chemicals into Japan decreased greatly, by 65%, to 237 tons of lithium equivalent. This was due to lowering of consumer inventories that had been accumulated in 1974 and a marked decrease in demand for lithium bromide in air conditioning. Markets were sought for Japanese air conditioning systems in Southeast Asia and the Middle East. Significant quantities of lithium mineral concentrates were imported, but tonnages were not available because they were included inseparably with other nonlithium-bearing minerals.

Mozambique.—Exports of lithium mineral concentrate, all to Western Europe, decreased 83% to about 2,300 tons in 1975. No concentrate was produced in Mozambique.

South Africa, Republic of, and Territory of South-West Africa.—No concentrate was produced in South Africa in 1975. Approximately 35,000 tons of concentrate was exported to the United Kingdom in 1974.

U.S.S.R.—Exports of lithium chemicals to Western Europe and Japan in 1975 were about 64% below those of 1974.

United Kingdom.—Associated Lead Manufactures Ltd., the only manufacturer of lithium chemicals in the United Kingdom, announced in 1975 that it was going out of the lithium chemical business, based on the loss of Rhodesian petalite as a raw material source for production.

Zaire.—Discovery of a zoned pegmatite near Manono, representing perhaps the largest lithium resource in the world and estimated to contain in excess of 1 million tons of lithium equivalent, was announced. A 5,000-ton-per-year lithium carbonate plant was planned, but financing was not arranged and no schedule was given.

Table 4.—Lithium minerals: World production by country

(Short tons)

Country [1] and minerals produced	1973	1974	1975 [p]
Argentina (minerals not specified)	110	181	[e] 185
Australia (minerals not specified)	[r] 245	1	--
Brazil:			
Amblygonite	491	188	[c] 6,000 (Amblygonite, Lepidolite, Petalite, Spodumene combined)
Lepidolite	273	507	
Petalite	2,623	3,934	
Spodumene	1,160	[e] 1,320	
Canada, spodumene [2]	205	786	--
China, People's Republic of (minerals not specified) [e 3]	10,000	10,000	10,000
Portugal, lepidolite	[r] 1,323	1,323	1,213
Rhodesia, Southern (minerals not specified) [e 3]	15,000	15,000	20,000
Rwanda, amblygonite	25	[e] 30	[e] 30
South Africa, Republic of, spodumene	--	[r] 1	--
South-West Africa, Territory of (minerals not specified) [4]	5,914	41,625	[e] 10,000
U.S.S.R. (minerals not specified) [e 3]	50,000	50,000	50,000
United States (minerals not specified)	W	W	W

[e] Estimate. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing individual company confidential information.

[1] In addition to the countries listed, other nations may produce small quantities of lithium minerals but output is not reported and no valid basis is available for estimating production levels.

[2] Figures presented are U.S. imports from Canada; official Canadian sources report no production since 1965, but the United States has imported lithium materials from Canada in most years since that time. It is not clear whether these imports are from: (1) accumulated stocks; (2) test production quantities not reported in official Canadian statistics; (3) Canadian imports; or (4) any combination of these sources.

[3] These estimates denote only an approximate order of magnitude; no basis for more exacting estimates is available. Output by China and the U.S.S.R. have never been reported; Southern Rhodesian output has not been reported since 1964.

[4] Output has not been officially reported since 1966, but presumably has continued since a number of countries record imports from "South Africa" which in total quantity considerably exceed reported output by the Republic of South Africa proper, and presumably include shipments from South-West Africa. Quantities given represent imports by the United States and the European Community reported as originating in South Africa, but the reader is cautioned that a portion of this material may have been mined in Southern Rhodesia. In 1966, actual output from South-West Africa totaled 1,739 short tons including: amblygonite—30; lepidolite—365; petalite—1,344.

Table 5.—Reported world trade in lithium chemicals [1]

(Short tons of contained lithium)

Importing countries	Source countries: United States 1974	United States 1975	U.S.S.R. 1974	U.S.S.R. 1975	Germany, West 1974	Germany, West 1975	Other 1974	Other 1975	Total 1974	Total 1975
Belgium-Luxembourg:										
Carbonate	r 4	NA	3	2	2	NA	r 14	14	23	16
Hydroxide	r 8	8	--	2	20	15	r 1	2	r 29	27
Chloride	NA	NA	NA	NA	[2] 1	--	NA	NA	[2] 1	--
Metal	--	NA	--	NA	--	NA	--	6	--	6
Total	12	8	3	4	23	15	r 15	22	r 53	49
France:										
Carbonate	r 34	23	r 15	--	20	21	5	3	74	47
Hydroxide	r 44	55	19	12	16	17	r 10	10	r 89	94
Chloride	NA	NA	NA	NA	[2] 14	[2] 9	NA	NA	[2] 14	[2] 9
Metal	r 2	--	--	--	6	3	r 1	5	r 9	8
Total	r 80	78	r 34	12	56	50	r 16	18	r 186	158
Germany, West:										
Carbonate	277	370	67	44	XX	XX	28	17	372	431
Hydroxide	41	46	28	19	XX	XX	13	18	82	83
Chloride	3	5	NA	NA	XX	XX	1	1	4	6
Metal	6	23	12	3	XX	XX	--	3	18	29
Total	327	444	107	66	XX	XX	42	39	476	549
Italy:										
Carbonate	5	14	2	--	17	14	r 1	14	25	42
Hydroxide	11	12	2	6	21	22	r 1	2	35	42
Chloride	NA	NA	--	--	[2] 4	[2] 5	--	--	[2] 4	[2] 5
Metal	--	NA	4	NA	r 4	NA	r 1	16	9	16
Total	16	26	r 8	6	r 46	41	r 3	32	73	105
Japan:										
Carbonate	278	93	274	42	2	--	5	(3)	559	135
Hydroxide	68	64	28	31	--	--	--	--	96	95
Chloride	(3)	(3)	--	--	r (2) (3)	--	--	--	(2) (3)	(3)
Bromide	[4] 13	(3) (4)	--	--	--	--	--	--	[4] 13	(3) (4)
Metal	18	7	--	(3)	(3)	(3)	--	(3)	18	7
Total	377	164	302	73	2	(3)	5	(3)	686	237
Netherlands:										
Carbonate	NA	NA	NA	NA	[2] 3	--	NA	NA	[2] 3	NA
Hydroxide	(4)	19	(4)	6	(3)	--	r 15	1	r 15	26
Chloride	NA	NA	NA	NA	[2] 11	[2] 14	NA	NA	[2] 11	[2] 14
Metal	--	--	--	--	--	1	--	--	--	1
Total	(5)	19	(5)	6	14	15	r 15	1	r 29	41

Spain:										
Carbonate	12	5	--	2	1	(3)	--	(3)	13	7
Hydroxide	17	19	(3)	3	9	7	1	1	27	30
Chloride	NA	NA	NA	NA	(3)	(3)	(3)	(3)	(3)	(3)
Metal	--	--	--	--	(3)	--	(3)	21	(3)	21
Total	29	24	(3)	5	10	7	1	22	40	58
Other countries:										
Carbonate	NA	NA	NA	NA	[2] 28	[2] 5	NA	NA	[2] 28	[2] 5
Hydroxide	NA	NA	NA	NA	[r,2] 43	[2] 33	NA	NA	[r,2] 43	[2] 33
Chloride	NA	NA	NA	NA	[2] 7	[2] 6	NA	NA	[2] 7	[2] 6
Metal	NA	NA	NA	NA	[r,2] 10	[2] 13	NA	NA	[r,2] 10	[2] 13
Total	NA	NA	NA	NA	[r] 88	57	NA	NA	[r] 88	57
Total: [6]										
Carbonate	[r] 610	505	361	90	[2] 73	[2] 40	[r] 53	48	1,097	683
Hydroxide	[r] 189	223	[r] 77	79	[r,2] 109	[2] 94	[r] 41	34	[r] 416	430
Chloride	3	5	NA	NA	[2] 37	[2] 34	1	1	41	40
Bromide	[4] 13	(3)	--	--	NA	NA	--	--	13	(3)
Metal	[r] 26	30	16	3	[r,2] 20	[2] 17	[r] 2	51	[r] 64	101
Total	[r] 841	763	[r] 454	172	[r] 239	185	[r] 97	134	[r] 1,631	1,254

[r] Revised. NA Not available. XX Not applicable.

[1] Compiled from import statistics of listed importing countries except where otherwise noted. Conversion from reported metric tons to short tons was accomplished by multiplying metric tons by 1.10231. Conversions to lithium content from reported gross weights were accomplished through the use of the following conversion factors: Lithium carbonate—multiply by 0.188; lithium hydroxide—multiply by 0.165; lithium chloride—multiply by 0.164; lithium bromide—multiply by 0.080. It should be noted that most of the reporting countries provide data for a basket category of "lithium oxide and hydroxide"; this has been assumed to be largely, if not entirely, the monohydrate form of lithium hydroxide ($LiOH \cdot H_2O$) and the factor selected for converting gross weight of this material to lithium content is based on this assumption.

[2] Source: West German official export statistics.

[3] Less than ½ unit.

[4] Source publication reports imports of the total of lithium bromide and potassium bromide as a single figure; entry here is an estimate based on the assumption that half of the total is lithium bromide.

[5] Receipts, of any, from this source are not reported separately, but are included in other.

[6] Totals are of listed figures only except where otherwise indicated; as such, they are only partial totals in most cases.

Table 6.—Lithium mineral concentrate: Imports of selected countries by country of origin[1]

(Short tons, gross weight)

Source country	Recipient country									
	Belgium-Luxembourg	Denmark	France	Germany, West	Ireland	Italy	Netherlands	United Kingdom	United States	Total
1974										
Producing countries:										
Brazil	--	--	--	--	--	--	--	--	2,379	2,379
Canada	--	--	--	--	--	--	--	--	786	786
Mozambique	7,971	--	1,069	194	--	--	[2] 4,363	43	--	r 13,640
South Africa, Republic of[3]	--	--	2,885	3,661	--	106	r 259	34,974	--	r 41,885
United States	--	--	500	559	--	--	[2] 309	2,468	XX	r 3,836
Nonproducing countries:										
Belgium-Luxembourg	--	--	--	--	--	--	[2] 6,633	--	--	r 6,633
Germany, West	([4])	--	--	XX	--	--	--	--	--	([4])
Greece	--	--	--	--	--	--	[2] 1,332	40,814	--	42,146
Italy	--	--	--	--	10	XX	--	110,422	--	r 110,432
Netherlands	r 314	--	686	217	--	99	XX	50	--	r 1,366
Unspecified countries	r 10	115	r 131	46	--	212	[2] 190	5,303	--	r 6,007
Total	8,295	115	r 5,271	4,677	10	417	r [2] 13,086	194,074	3,165	r 229,110
1975										
Producing countries:										
Brazil	--	--	--	--	NA	NA	--	NA	4,548	4,548
Canada	--	--	--	--	NA	NA	--	NA	--	NA
Mozambique	834	--	--	--	NA	NA	[2] 1,465	NA	--	2,299
South Africa, Republic of[3]	3,747	--	656	3,303	NA	535	[2] 567	NA	--	8,808
United States	--	--	245	353	NA	NA	[2] 44	NA	XX	642
Nonproducing countries:										
Belgium-Luxembourg	NA	--	--	NA	NA	NA	--	NA	--	NA
Germany, West	NA	--	--	XX	NA	NA	[2] 153	NA	--	153
Greece	--	--	--	NA	NA	NA	[2] 2,522	NA	--	2,522
Italy	NA	--	--	NA	NA	XX	--	NA	--	NA
Netherlands	NA	--	348	NA	NA	NA	XX	NA	--	348
Unspecified countries	474	34	301	225	NA	316	[2] 906	NA	--	2,256
Total	5,055	34	1,550	3,881	NA	851	[2] 5,657	NA	4,548	21,576

r Revised. XX Not applicable. NA Not available.
[1] Compiled from import statistics of listed recipient countries.
[2] Data may include minerals other than lithium concentrates. Nonexpanded vermiculite, chlorite and perlite, if any, are included.
[3] Includes materials from the Territory of South-West Africa and possibly Southern Rhodesia.
[4] Less than ½ unit.

TECHNOLOGY

Studies[4] at North Carolina State University on recovery of spodumene ore by froth flotation resulted in adoption of ball mill grinding on a commercial scale in the North Carolina spodumene industry. Prior to 1973, rod milling had been used exclusively in this industry.

Argonne National Laboratory continued development of a rechargeable lithium cell for automotive and energy-storage use. This lithium-sulfur cell has a solid lithium-aluminum alloy anode, an iron sulfide cathode (either FeS or FeS_2), a molten LiCl-LiF eutectic electrolyte, and a cell chamber separator made of boron nitride fabric. The cell operates at between 380° and 450° C, has a specific energy five times that of a lead-acid storage cell, and operates at a 1.5-volt output. Cell-life goal was 8 years. In 1975, cell life of 5 months was attained and this included several hundred charge-discharge cycles. A major effort to lower cell fabrication cost is continuing.

Eagle-Picher Industries, Inc., announced a plan to build the first privately owned and operated commercial facility in the United States for production of Li_7 isotope for the nuclear power industry. Operation was expected by 1977. Lithium is used to control the pH level in primary cooling systems of pressurized water reactors. Impact on the lithium industry was considered to be negligible since the total lithium requirement would not be more than about 1 ton per year.

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[4] Redeker, I. H. Flotation of Fine Ball Mill Ground Spodumene From North Carolina Ores. N.C. State Univ. Rept. MRL–5, March 1975, 38 pp.

Magnesium

By Benjamin Petkof [1]

World production of primary magnesium metal was slightly lower than that of 1974. Domestic primary metal production remained strong but declined from that of 1974. A significant quantity of secondary magnesium was also produced. Exports declined but imports increased. The quoted price of magnesium metal was higher than that of 1974 but was stable during the entire year.

Table 1.—Salient magnesium statistics
(Short tons)

	1971	1972	1973	1974	1975
United States:					
Production:					
Primary magnesium	123,485	120,823	122,431	W	W
Secondary magnesium	14,703	15,628	17,636	14,874	27,276
Shipments: Primary	120,217	111,185	137,277	W	W
Exports	24,311	17,566	39,585	46,398	32,591
Imports for consumption	3,671	4,479	3,325	5,305	7,903
Consumption	92,166	103,691	115,774	130,048	94,815
Price per pound ---- cents	36.25	37.25	38.25	41.25–75.00	82.00
World: Primary production	255,753	257,529	[r] 264,647	[1] 144,686	[1] 141,980

[r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Excludes United States production.

Legislation and Government Programs.—The General Services Administration strategic and critical stockpile contained 1,621 tons of magnesium at yearend 1975. There were no stockpile releases or accessions during the year.

DOMESTIC PRODUCTION

Magnesium ingot producers during 1975 were American Magnesium Co., Snyder, Tex., with an annual capacity of 10,000 short tons; The Dow Chemical Co., Freeport, Tex., with an annual production capacity of 120,000 short tons; and NL Industries, Inc., Rowley, Utah, with an annual capacity of 45,000 short tons. The electrolytic method was used by all domestic producers. Publication of Bureau of Mines data on domestic production is withheld to avoid disclosing individual company confidential data.

Northwest Alloys, Inc., a wholly-owned subsidiary of the Aluminum Co. of America (Alcoa) continued construction of its magnesium facilities at Addy, Wash. The facility was expected to commence operation in 1976 The future output of this plant will be utilized by Alcoa for production of aluminum alloys. Planned initial production capacity was 24,000 tons per year.

[1] Physical scientist, Division of Nonferrous Metals.

Table 2.—Magnesium recovered from scrap processed in the United States, by kind of scrap and form of recovery
(Short tons)

	1971	1972	1973	1974	1975
Kind of scrap:					
New scrap:					
Magnesium-base	6,722	6,993	7,417	3,357	4,076
Aluminum-base	4,838	5,646	6,118	5,798	13,417
Total	11,560	12,639	13,535	9,155	17,493
Old scrap:					
Magnesium-base	1,719	1,445	2,529	4,161	4,873
Aluminum-base	1,424	1,544	1,572	1,558	4,910
Total	3,143	2,989	4,101	5,719	9,783
Grand total	14,703	15,628	17,636	14,874	27,276
Form of recovery:					
Magnesium alloy ingot [1]	3,905	3,612	2,606	2,703	2,796
Magnesium alloy castings (gross weight)	14	9	12	14	750
Magnesium alloy shapes	500	275	169	4	1,262
Aluminum alloys	7,423	8,790	9,206	9,316	19,731
Zinc and other alloys	17	14	31	16	12
Chemical and other dissipative uses	478	794	567	44	44
Cathodic protection	2,366	2,134	5,045	2,777	2,681
Total	14,703	15,628	17,636	14,874	27,276

[1] Includes secondary magnesium content of both secondary and primary alloy ingot.

CONSUMPTION AND USES

Following the general economic decline, domestic magnesium consumption in 1975 dropped 27% below that of 1974 to 94,815 tons. Magnesium was consumed in structural products that included castings and wrought products, and in sacrificial purposes where advantage was taken of the metal's chemical and alloying properties. The metal's useful structural properties such as low specific weight, good machinability, hot formability, and high strength-to-weight ratio resulted in about 21% of consumption being used for structural applications in aircraft, automotive, and other types of transportation equipment, materials handling equipment, and the manufacture of items such as power tools. The remainder was used for sacrificial purposes, primarily alloying with other metals (49%), cathodic protection (5%), production of nodular iron (14%), and reducing agents for metals such as titanium, zirconium, hafnium, uranium, and beryllium (7%).

Table 3.—Consumption of primary magnesium in the United States, by use
(Short tons)

	1971	1972	1973	1974	1975
For structural products:					
Castings:					
Die	7,469	9,326	9,999	11,804	6,842
Permanent mold	142	736	812	1,000	1,245
Sand	765	700	1,326	1,372	2,010
Wrought products:					
Extrusions	5,587	7,749	7,436	7,323	6,221
Sheet and plate	2,918	3,817	([1])	([1])	([1])
Other (includes forgings)	2,212	1,381	5,529	6,025	3,454
Total	19,093	23,709	25,102	27,524	19,772

See footnotes at end of table.

Table 3.—Consumption of primary magnesium in the United States, by use—Continued
(Short tons)

	1971	1972	1973	1974	1975
For distributive or sacrificial purposes:					
Alloys:					
Aluminum	37,450	43,458	51,953	62,152	46,693
Copper	163	38	503	19	13
Zinc	24	28	30	24	15
Other	37	109	13	16	11
Cathodic protection (anodes)	7,296	6,543	9,931	10,439	4,709
Chemicals	8,960	9,732	9,835	9,204	2,592
Nodular iron	6,590	7,603	8,724	10,603	12,864
Scavenger and deoxidizer	68	327	50	285	(1)
Reducing agent for titanium, zirconium, hafnium, uranium, and beryllium	9,053	6,089	7,367	7,569	7,007
Other, including powder	3,432	6,055	2,266	2,213	1,139
Total	73,073	79,982	90,672	102,524	75,043
Grand total	92,166	103,691	115,774	130,048	94,815

[1] Included with "Other."

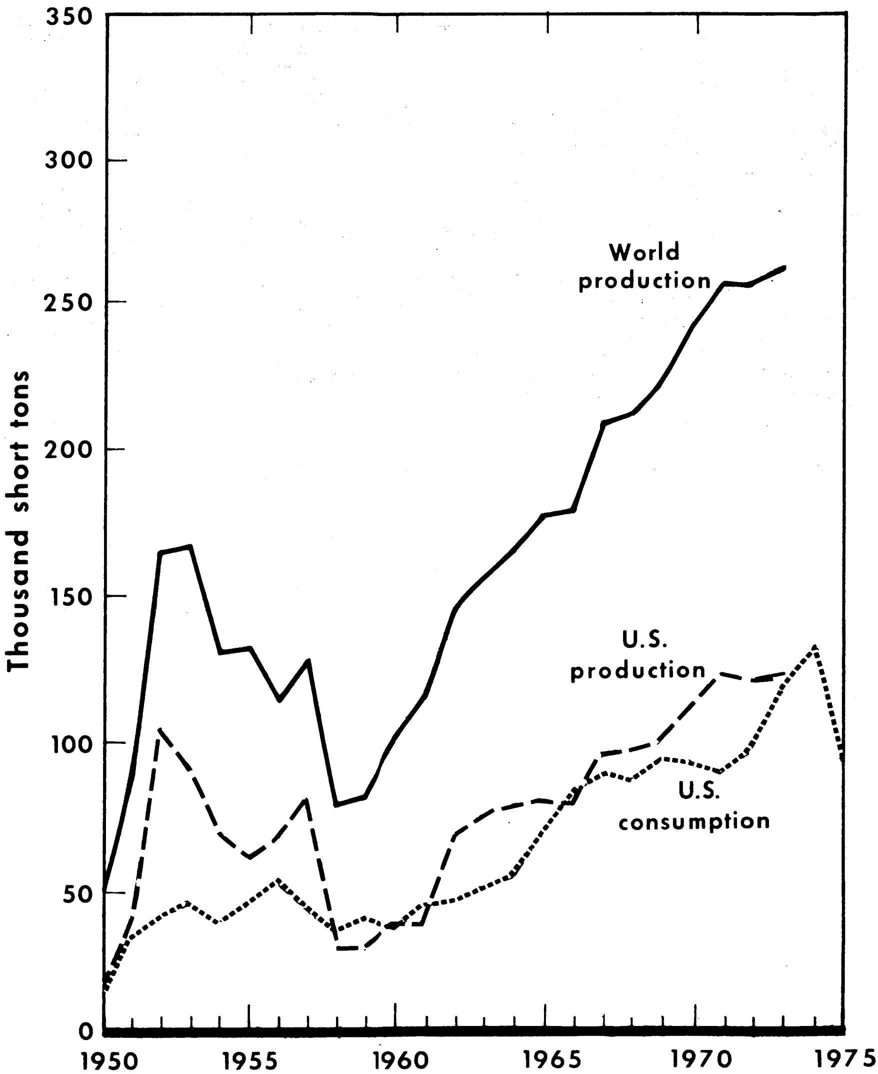

Figure 1.—U.S. and world production and U.S. consumption of primary magnesium

PRICES

The base price of magnesium ingot was stable during 1975 and was quoted at $0.82 per pound for 99.8% purity metal, minimum 10,000-pound lots, f.o.b. plant. As of January 1, 1976, the quoted price increased by $0.05 to $0.87 per pound.

STOCKS

Producer and consumer stocks of primary magnesium declined 7% to 19,664 tons at yearend 1975. Yearend stocks of primary magnesium alloy ingot dropped 10% to 1,512 tons. Stocks of primary metal at yearend 1974 were 21,106 tons, and those of alloy ingot 1,677 tons. New and old magnesium scrap stocks declined 39%.

Table 4.—Stocks and consumption of new and old magnesium scrap in the United States in 1975
(Short tons)

Item	Stocks Jan 1 r	Receipts	Consumption			Stocks Dec. 31
			New scrap	Old Scrap	Total	
Cast scrap	1,096	5,540	447	5,475	5,922	714
Solid wrought scrap [1]	207	496	618	--	618	85
Total	1,303	6,036	1,065	5,475	6,540	799

r Revised.
[1] Includes borings, turnings, drosses, etc.

FOREIGN TRADE

The quantity of magnesium exported declined 30% from 46,398 tons in 1974 to 32,591 tons in 1975. However, the value declined only slightly from $48.5 million in 1974 to $48.2 million in 1975. Shipments to Brazil, Canada, West Germany, Japan, Mexico, and the Netherlands represented 92% of the total. Almost all the magnesium exported (95%) consisted of primary metal and alloys.

Total magnesium imports for consumption increased 49% from 5,305 tons valued at $5.2 million in 1974 to 7,903 tons valued at $11.5 million in 1975. Imports of metal accounted for 61% of total imports; waste and scrap 25%; and alloys and other forms, 14%. Major sources of magnesium imports were: Canada (21%); Norway (25%); and Japan (22%).

Table 5.—U.S. exports of magnesium by class and country

Destination	1974 Waste and scrap: Quantity (short tons)	1974 Waste and scrap: Value (thousands)	1974 Primary metals alloys: Quantity (short tons)	1974 Primary metals alloys: Value (thousands)	1974 Semifabricated forms, n.e.c., including powder: Quantity (short tons)	1974 Semifabricated forms, n.e.c., including powder: Value (thousands)	1975 Waste and scrap: Quantity (short tons)	1975 Waste and scrap: Value (thousands)	1975 Primary metals alloys: Quantity (short tons)	1975 Primary metals alloys: Value (thousands)	1975 Semifabricated forms, n.e.c., including powder: Quantity (short tons)	1975 Semifabricated forms, n.e.c., including powder: Value (thousands)
Argentina	--	--	427	$671	5	$41	--	--	187	$322	1	$8
Australia	--	--	540	738	11	41	--	--	226	343	1	3
Austria	--	--	--	--	8	21	--	--	2	1	13	55
Belgium-Luxembourg	--	--	--	--	(1)	2	--	--	815	981	3	12
Brazil	(1)	$1	6,101	6,305	1	10	29	$44	7,300	10,999	1	12
Canada	41	103	6,828	7,379	136	334	51	72	6,603	10,466	70	211
Colombia	--	--	28	40	1	2	--	--	--	--	5	5
France	39	52	385	341	11	69	--	--	65	175	10	107
Germany, West	17	73	6,226	7,150	531	1,683	--	--	2,146	3,438	578	1,940
Ghana	--	--	525	1,019	2	1	--	--	115	197	--	--
India	--	--	130	166	--	--	--	--	102	157	--	--
Israel	--	--	68	44	82	242	--	--	6	36	--	--
Italy	59	27	524	554	2	12	--	--	63	189	22	112
Japan	--	--	4,388	4,384	246	506	9	8	4,964	6,329	226	642
Korea, Republic of	--	--	11	10	--	--	5	7	26	48	--	--
Mexico	2	3	5,489	5,393	10	17	22	81	1,372	2,197	56	94
Netherlands	--	--	5,991	4,396	33	84	--	--	6,418	7,379	7	26
New Zealand	--	--	100	111	2	3	--	--	--	--	--	--
Norway	--	--	1,532	1,279	1	2	--	--	--	--	1	20
South Africa, Republic of	--	--	575	662	--	--	--	--	329	600	6	69
Spain	--	--	544	408	19	52	--	--	10	16	20	58
Taiwan	644	102	369	411	5	13	360	91	15	17	(1)	1
United Kingdom	--	--	2,645	2,298	37	170	--	--	234	384	6	29
Venezuela	--	--	346	387	(1)	3	--	--	4	9	--	--
Other	1	4	668	631	12	61	--	--	45	109	42	92
Total	803	365	44,440	44,777	1,155	3,369	476	303	31,047	44,392	1,068	3,496

[1] Less than ½ unit.

Table 6.—U.S. exports and imports for consumption of magnesium

Year	Exports: Waste and scrap: Quantity (short tons)	Exports: Waste and scrap: Value (thousands)	Exports: Metals and alloys in crude forms: Quantity (short tons)	Exports: Metals and alloys in crude forms: Value (thousands)	Exports: Semifabricated forms, n.e.c.: Quantity (short tons)	Exports: Semifabricated forms, n.e.c.: Value (thousands)
1973	44	$81	38,323	$25,934	1,218	$2,227
1974	803	365	44,440	44,777	1,155	3,369
1975	476	303	31,047	44,392	1,068	3,496

Year	Imports: Waste and scrap: Quantity (short tons)	Imports: Waste and scrap: Value (thousands)	Imports: Metal: Quantity (short tons)	Imports: Metal: Value (thousands)	Imports: Alloys (magnesium content): Quantity (short tons)	Imports: Alloys (magnesium content): Value (thousands)	Imports: Powder, sheets, tubing, ribbons, wire and other forms (magnesium content): Quantity (short tons)	Imports: Powder, sheets, tubing, ribbons, wire and other forms (magnesium content): Value (thousands)
1973	2,296	$952	620	$485	389	$1,104	20	$129
1974	4,320	2,826	495	692	440	1,573	50	135
1975	1,984	1,564	4,803	7,735	1,111	2,215	5	33

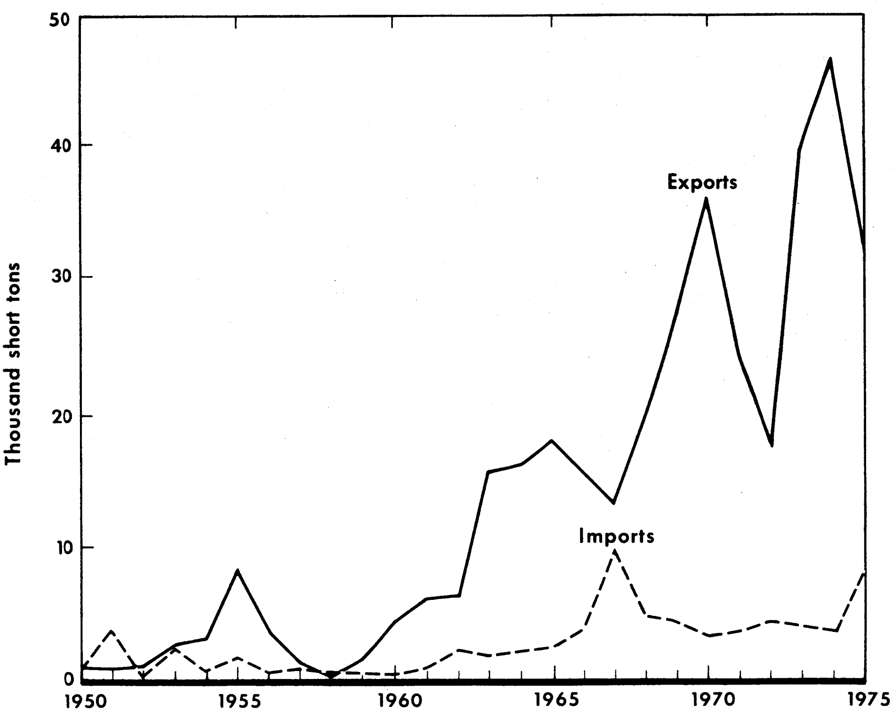

Figure 2.—U.S. imports and exports of magnesium.

WORLD REVIEW

World magnesium production (excluding U.S. production) declined from 144,686 tons in 1974 to 141,980 tons in 1975. The U.S.S.R. produced 49% of the world magnesium output (excluding U.S. production) followed by Norway (30%); Japan (7%); and France (6%). The remainder was supplied by Canada, the People's Republic of China, and Italy.

Table 7.—Magnesium: World production,[1] by country
(Short tons)

Country	1973	1974	1975 p
Canada	6,840	6,566	4,961
China, People's Republic of e	1,100	1,100	1,100
France	r 7,710	7,199	8,307
Italy	9,850	10,119	6,993
Japan [2]	12,349	9,836	9,412
Norway	r 41,367	43,866	42,207
U.S.S.R. e	63,000	66,000	69,000
United States	[3] 122,431	W	W
Total	r 264,647	[4] 144,686	[4] 141,980

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Primary only.
[2] Secondary production was as follows in short tons: 1973—8,936; 1974—11,990; and 1975 (preliminary)—10,171.
[3] Dow Chemical Company only.
[4] Excludes United States production, which in previous years accounted for approximately 50% of the total.

Canada.—Chromasco Ltd. was the only primary metal producer and has operated a mine and smelter at Haley, Ontario, since 1942 using the silicothermic process. Canada consumed 6,853 tons of metal in 1974 with the major portion used by the aluminum industry. The casting industry also consumed a significant quantity of the metal. Canada imported 6,886 tons and exported 3,521 tons of magnesium metal in 1974.

Japan.—About 18,000 tons of both primary and secondary magnesium metal were produced in 1975. Imports and exports amounted to 4,563 tons and 2,549 tons, respectively. Consumption (probably both primary and secondary) was 20,193 tons of magnesium metal for uses such as reducing titanium and zirconium in smelting plants, production of aluminum-magnesium alloys, and manufacture of rolled products, casting nodular cast iron, magnesium powder, and cathodic protection anodes.[2]

Yugoslavia.—A new installation for production of magnesium metal may be built near Boljevac na Ibru. Details about size and cost were not made public.

TECHNOLOGY

The National Research Council published a review of magnesium metal usage and future trends.[3]

The basic Alcan-type magnesium cell was modified to improve operation and magnesium metal recovery from magnesium chloride which is generated in producing titanium.[4]

The problem of recycling automotive scrap was reviewed. Methods for scrap processing and separation of individual metals such as aluminum and magnesium were discussed and evaluated.[5]

New equipment was developed for producing ductile iron. The equipment has a cylindrical ladle for hot metal that incorporates a plunger through which a magnesium additive flows. It was claimed that

[2] Japan Metal Journal. Magnesium Industry in 1975. V. 6, No 15, Apr. 12, 1976, p. 7.
[3] Commission on Sociotechnical Systems. National Research Council-National Academy of Sciences. Trends in the Usage of Magnesium. 1975, 114 pp.
[4] Sevelotti, O. G., N. Vandermeulen, J. Iseki, and T. Izumi. Proc. of Sessions, 105th AIME Ann. Meeting, Las Vegas, Nev. Light Metals Committee, The Metallurgical Society of AIME, New York, N.Y., 10017, v. 1, p. 437–455.
[5] Lockwood, L. F. Magnesium: A Recyclable Automotive Material. Proc., 32d Ann. Meeting, Internat. Magnesium Assoc. Dearborn, Mich., May 18–21, 1975, pp. 31–39.

use of this equipment recovers about 70% of magnesium metal.[6]

Factors such as alloy selection, storage, size, and ladle design to improve the efficiency of magnesium in producing ductile iron were described.[7]

A method was developed to produce magnesium from dolomite. Calcined dolomite was mixed with silicon or ferrosilicon, briquetted, and heated to a temperature of 1,050° to 1,200° C in an inert atmosphere and under optimum pressure. Vaporization of the magnesium formed in this step was inhibited and calcium-silicon alloy was formed within the briquettes. The magnesium in the briquettes was recovered by melting in an internally heated furnace.[8]

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[6] Foundry. Japanese Equipment for Ductile Iron. V. 103, No. 1, January 1975, p. 59.

[7] Patterson, V. H. Improving Magnesium Recovery in Ductile Iron. Foundry, v. 103, No. 2, February 1975, pp. 80–84.

[8] Matushima, T., and T. Odajima (assigned to Showa Denko K. K.). Silicothermic Reduction Method for Producing Magnesium From Dolomite. U.S. Pat. 3,918,959, Nov. 11, 1975.

Magnesium Compounds

By Benjamin Petkof [1]

World magnesite production remained strong during 1975 with Austria, Greece, the U.S.S.R., the People's Republic of China, and North Korea providing about three-fourths of world output. However, refractory magnesia and caustic-calcined and specified magnesias, sold or used by domestic producers in 1975, declined in both quantity and value.

Exports of magnesite and magnesia totaled 91,752 tons, an increase of 48% above that of 1974. The bulk of shipments were destined to Canada, West Germany, Mexico, and Austria. Imports for consumption of processed magnesite were almost unchanged from those of 1974.

Table 1.—Salient magnesium compound statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Caustic-calcined and specified magnesias: [1]					
Shipments by producers:					
Quantity	127	128	158	149	120
Value	18,621	15,856	26,929	27,916	17,207
Exports: Value [2]	2,840	3,377	4,196	5,088	4,538
Imports for consumption: Value [2]	736	675	734	692	502
Refractory magnesia:					
Sold and used by producers:					
Quantity	627	696	807	803	709
Value	50,359	60,331	69,904	77,044	103,839
Exports: Value	5,897	5,903	6,104	7,749	14,146
Imports: Value	9,219	9,300	13,469	16,463	20,588
Dead-burned dolomite:					
Sold and used by producers:					
Quantity	1,007	1,075	1,250	1,277	914
Value	18,883	20,158	23,441	32,078	31,193
World: Crude magnesite production:					
Quantity	10,061	9,884	r 10,162	r 11,090	10,995

r Revised.
[1] Excludes caustic-calcined magnesia used in production of refractory magnesia.
[2] Caustic-calcined magnesia only.

DOMESTIC PRODUCTION

Barcroft Co., The Dow Chemical Co., Harbison-Walker Refractories, Kaiser Aluminum & Chemical Corp., Merck & Co., Inc., and Michigan Chemical Corp. produced magnesium hydroxide from seawater and well brines. The magnesium hydroxide was used primarily to produce magnesia for basic refractories. Producers of refractory magnesia were Basic, Inc., Basic Magnesia, Inc., Cohart Refractories Co., Inc., A. P. Green Refractories, Co., Harbison-Walker Refractories, Kaiser Aluminum & Chemical Corp., and Martin-Marietta Chemicals. Total production of refractory magnesia in 1975 was 722,554 tons.

Caustic-calcined magnesia was produced by Basic, Inc., Basic Magnesia, Inc., The Dow Chemical Co., Kaiser Aluminum & Chemical Corp., Martin Marietta Chemicals, and Michigan Chemical Corp. Total production of caustic-calcined magnesia

[1] Physical scientist, Division of Nonferrous Metals.

was 165,380 tons. Merck & Co., Inc., Michigan Chemical Corp., and Morton Chemical Co. produced 10,183 tons of specified magnesia. The Dow Chemical Co., Mallinckrodt Chemical Works, and Philadelphia Quartz Co. produced hydrous and anhydrous magnesium sulfate. Magnesium carbonate was produced by Mallinckrodt Chemical Works, Merck & Co., Inc., Michigan Chemical Corp., and Morton Chemical Co.

Magnesium chloride was produced by American Magnesium Co., The Dow Chemical Co., FMC Corp., Great Salt Lake Minerals & Chemicals Corp., and Kaiser Aluminum & Chemical Corp. Most of the magnesium chloride production was used to produce magnesium metal.

Domestic producers of magnesium compounds by raw material source, location, and capacity follow:

Raw material source and producing company	Location	Capacity (short ton of MgO equivalent)
Magnesite: Basic, Inc	Gabbs, Nev	150,000
Lake brines:		
Great Salt Lake Minerals & Chemicals Corp	Ogden, Utah	100,000
Kaiser Aluminum & Chemical Corp	Wendover, Utah	50,000
Well brines:		
The Dow Chemical Co	Ludington, Mich	250,000
Martin Marietta Chemicals	Manistee, Mich	280,000
Michigan Chemical Corp	St. Louis, Mich	25,000
Morton Chemical Co	Manistee, Mich	5,000
Seawater:		
Barcroft Co	Lewes, Del	5,000
Basic Magnesia, Inc	Port St. Joe, Fla	100,000
Cohart Refractories Co	Pascagoula, Miss	40,000
The Dow Chemical Co	Freeport, Tex	100,000
FMC Corp	Chula Vista, Calif	5,000
Harbison-Walker Refractories Co	Cape May, N.J	100,000
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif	150,000
Merck & Co., Inc	South San Francisco, Calif	10,000
Total		1,370,000

CONSUMPTION AND USES

Domestic use of almost all magnesium compounds declined in 1975, following the general pattern of decreased domestic economic activity. The major end use for magnesia continued to be the manufacture of refractories. Refractory magnesia consumption declined 12% in quantity but increased 35% in value from that of 1974. The consumption of caustic calcined and specified magnesia declined 20%; magnesium hydroxide 35%; magnesium sulfate 38%. Magnesium carbonate consumption increased 18%.

The quantity of caustic-calcined magnesias used for the manufacture of agricultural, nutritional, and pharmaceutical products decreased 1%; construction materials decreased 4%; chemical processing, manufacturing, and metallurgical decreased 23%.

Magnesia had a wide area of use including the production of animal feed, fertilizers and pharmaceuticals, and other chemical processing and manufacturing applications.

Table 2.—Magnesium compounds shipped and used in the United States

	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Caustic-calcined [1] and specified (USP and technical) magnesias	148,827	$27,916	119,551	$17,207
Refractory magnesia	802,673	77,044	709,474	103,839
Magnesium hydroxide (100% $Mg(OH)_2$) [1]	r 93,064	r 5,584	60,344	5,410
Magnesium sulfate (anhydrous and hydrous)	6,502	6,281	47,458	6,406
Precipitated magnesium carbonate [1]	5,903	2,161	6,982	1,605

r Revised.
[1] Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.

Table 3.—Domestic shipments of caustic-calcined and specified magnesias, by use
(Short tons)

Use	1974	1975
Agriculture, nutrition, and pharmaceuticals:		
Animal feed	W	23,371
Fertilizer	9,629	7,840
Medicinals and pharmaceuticals	2,620	2,186
Sugar and candy	3,716	W
Winemaking	W	W
Total	39,674	39,229
Construction materials:		
Insulation and wallboard	(1)	(1)
Oxychloride and oxysulfate cement	19,275	18,456
Total	19,275	18,456
Chemical, processing, manufacturing, and metallurgical:		
Chemical	13,874	7,481
Electrical heating rods	12,166	8,179
Flux	W	W
Petroleum additive	12,075	8,890
Pulp and paper	16,355	12,799
Rayon	14,170	10,989
Rubber	8,526	7,315
Stack gas scrubbing	W	W
Uranium processing	W	W
Water treatment	W	2,258
Total	80,838	61,866
Unspecified uses	9,040	--
Grand total	148,827	119,551

W Withheld to avoid disclosing individual company confidential data; included with "Total."
[1] Included with "Oxychloride and oxysulfate cement."

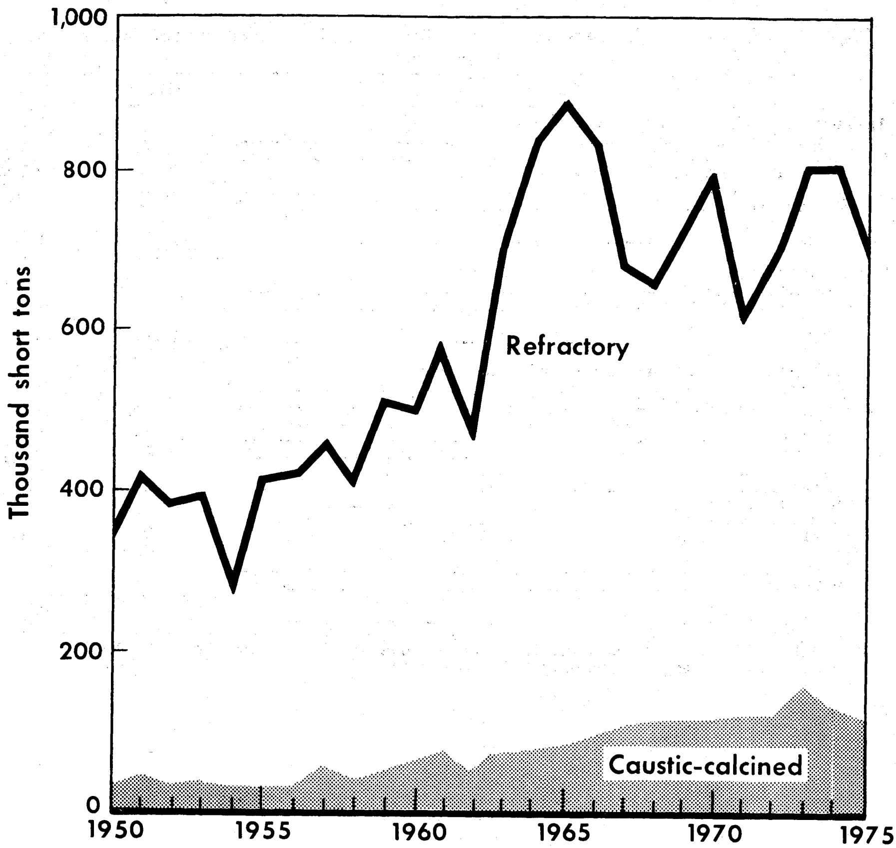

Figure 1.—Consumption and shipments of magnesia in the United States.

PRICES

The prices for magnesia, natural, technical, heavy, 85% and 90% (bulk, carlot and truckload, f.o.b. Luning, Nev.) were quoted at yearend at $85 and $105 per short ton, respectively, according to the Chemical Marketing Reporter. Magnesia, technical, neoprene-grade, light, was quoted at $346 per ton (bags, carlot and truckload, works).

Prices throughout the year for magnesium carbonate, technical (bags, carlot, freight-equalized) were quoted at $0.22 to $0.23 per pound, and NF grade, $0.30 to $0.31 per pound. During the year, the price for magnesium hydroxide, NF, powder, (drums, carlot and truckload, works) was $0.35 to $0.36 per pound. Magnesium chloride, hydrous, 99%, flakes (bags, carlot, works) was quoted at $120 per ton.

The price for magnesium sulfate, technical (bags, mixed carlot, 10,000-pound minimum, works) was quoted at $0.06 per pound.

FOREIGN TRADE

Exports of dead-burned magnesite and magnesia totaled 82,654 tons, valued at $14.1 million, an increase of 61% in quantity, and 83% in value. Shipments to Canada increased 22% from those of 1974 and represented 59% of total material exported. Significant quantities were also exported to West Germany (18%), Mexico (9%), Austria (5%), the Republic of South Africa (4%), and Chile (2%).

Exports of magnesite, including crude, caustic-calcined, lump or ground, declined 15% in quantity and 11% in value from those of 1974. Shipments to Canada, Yugoslavia, the Netherlands, and West Germany accounted for 70% of exports in this category.

Imports of lump, ground, caustic-calcined magnesias declined 43% to 5,716 tons in 1975. Most of the imports were received from India (75%), Australia (12%), Turkey (10%), and the Netherlands (3%). Imports of dead-burned and grain magnesia and periclase containing a maximum of 4% lime decreased from 131,978 tons in 1974 to 125,540 tons in 1975, a decline of 5%. Imports of the same material, but containing over 4% lime, rose 26% from 24,423 tons in 1974 to 30,792 tons in 1975. Total imports of crude and processed magnesite declined 2%, from 165,391 tons in 1974 to 162,048 tons in 1975.

Imports of specified magnesium compounds and compounds not specifically provided for were valued at $1,793,000.

Table 4.—U.S. exports of magnesite and magnesia, by country

Destination	Magnesite and magnesia, dead-burned				Magnesite, n.e.c. including crude caustic-calcined, lump or ground			
	1974		1975		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	--	--	--	--	145	$93	51	$36
Australia	42	$4	225	$34	752	504	216	170
Austria	--	--	4,473	60	11	6	--	--
Belgium-Luxembourg	3	1	--	--	58	31	31	17
Brazil	18	12	51	41	281	120	80	50
Canada	39,649	5,016	48,438	6,970	2,635	782	2,470	1,118
Chile	501	59	1,729	309	33	14	9	6
Colombia	16	14	1	(1)	61	39	77	48
Denmark	--	--	11	2	34	15	--	--
Finland	--	--	17	5	145	87	48	32
France	--	--	20	3	524	306	271	168
Germany, West	5,542	1,016	14,499	3,172	1,386	756	659	461
Israel	--	--	--	--	41	24	28	18
Italy	--	--	1,200	230	521	265	263	135
Japan	66	36	15	12	147	115	36	34
Korea, Republic of	--	--	--	--	42	17	7	5
Mexico	15	9	7,609	1,141	34	21	14	9
Netherlands	3,558	650	15	4	270	255	961	756
Netherlands Antilles	--	--	4	1	65	9	65	9
New Zealand	--	--	16	15	235	172	36	32
Peru	--	--	--	--	12	5	26	14
Philippines	181	70	102	37	203	81	20	12
South Africa, Republic of	274	139	3,265	891	117	75	154	92
Spain	6	4	18	9	286	120	62	41
Sweden	90	78	44	42	501	335	343	289
Switzerland	55	16	16	5	63	29	2	1
Taiwan	261	87	--	--	71	34	24	10
U.S.S.R	652	310	--	--	--	--	--	--
United Kingdom	238	197	767	418	748	415	449	281
Venezuela	30	6	--	--	1,184	249	253	78
Yugoslavia	--	--	--	--	80	56	2,291	523
Other	70	25	119	745	48	58	152	93
Total	51,267	7,749	82,654	14,146	10,733	5,088	9,098	4,538

[1] Less than ½ unit.

Table 5.—U.S. imports for consumption of crude and processed magnesite, by country

Country	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Lump or ground caustic-calcined magnesia: [1]				
Australia	242	$38	692	$102
Austria	60	3	--	--
Canada	92	15	--	--
India	5,476	296	4,298	286
Japan	--	--	2	8
Malaysia	220	10	--	--
Netherlands	616	67	167	24
Sweden	--	--	6	2
Turkey	2,284	263	551	80
Total	8,990	692	5,716	502
Dead-burned and grain magnesia and periclase:				
Not containing lime or not over 4% lime:				
Australia	882	118	607	84
Austria	12,575	1,366	2,200	280
Canada	56	14	67	13
China, People's Republic of	--	--	784	114
Cyprus	--	--	1,763	236
Finland	--	--	1,694	215
France	--	--	(2)	1
Greece	54,419	7,311	68,844	11,713
Ireland	42,298	5,331	40,756	6,759
Italy	2,772	300	--	--
Japan	2,216	181	1,653	214
Turkey	--	--	224	33
United Kingdom	12,607	1,445	4,739	687
Yugoslavia	4,153	397	2,209	239
Total	131,978	16,463	125,540	20,588
Containing over 4% lime:				
Austria	1,411	145	6,185	814
Canada	5,601	334	900	50
Greece	3,968	511	9,290	1,240
Japan	1	1	--	--
Spain	--	--	2,752	385
United Kingdom	--	--	1,870	209
Yugoslavia	13,442	1,001	9,795	1,382
Total	24,423	1,992	30,792	4,080
Total dead-burned and grain magnesia and periclase	156,401	18,455	156,332	24,668

[1] In addition, crude magnesite was imported as follows: 1974—India, 19 short tons ($1,396); 1975—India, 7 short tons ($577), and the United Kingdom, 3 short tons ($280).
[2] Less than ½ unit.

Table 6.—U.S. imports for consumption of magnesium compounds

Year	Oxide or calcined magnesia Quantity (short tons)	Oxide or calcined magnesia Value (thousands)	Magnesium carbonate [1] (precipitated) Quantity (short tons)	Magnesium carbonate [1] (precipitated) Value (thousands)	Magnesium chloride (anhydrous) Quantity (short tons)	Magnesium chloride (anhydrous) Value (thousands)	Magnesium chloride (other) Quantity (short tons)	Magnesium chloride (other) Value (thousands)	Magnesuim sulfate (epsom salts and kieserite) Quantity (short tons)	Magnesuim sulfate (epsom salts and kieserite) Value (thousands)	Magnesium salts and compounds n.s.p.f.[2] Quantity (short tons)	Magnesium salts and compounds n.s.p.f.[2] Value (thousands)
1973	673	$292	138	$88	121	$45	301	$16	52,489	$962	3,307	$477
1974	357	231	117	109	309	190	244	12	25,644	702	5,393	863
1975	360	148	63	97	103	42	50	9	32,991	1,070	2,999	427

[1] In addition, magnesium carbonate not precipitated, was imported in 1973—5 short tons ($1,436), 1974—19 short tons ($6,961), 1975—6 short tons ($2,226).
[2] Not specifically provided for; includes magnesium silicofluoride or fluosilicate and calcined magnesium.

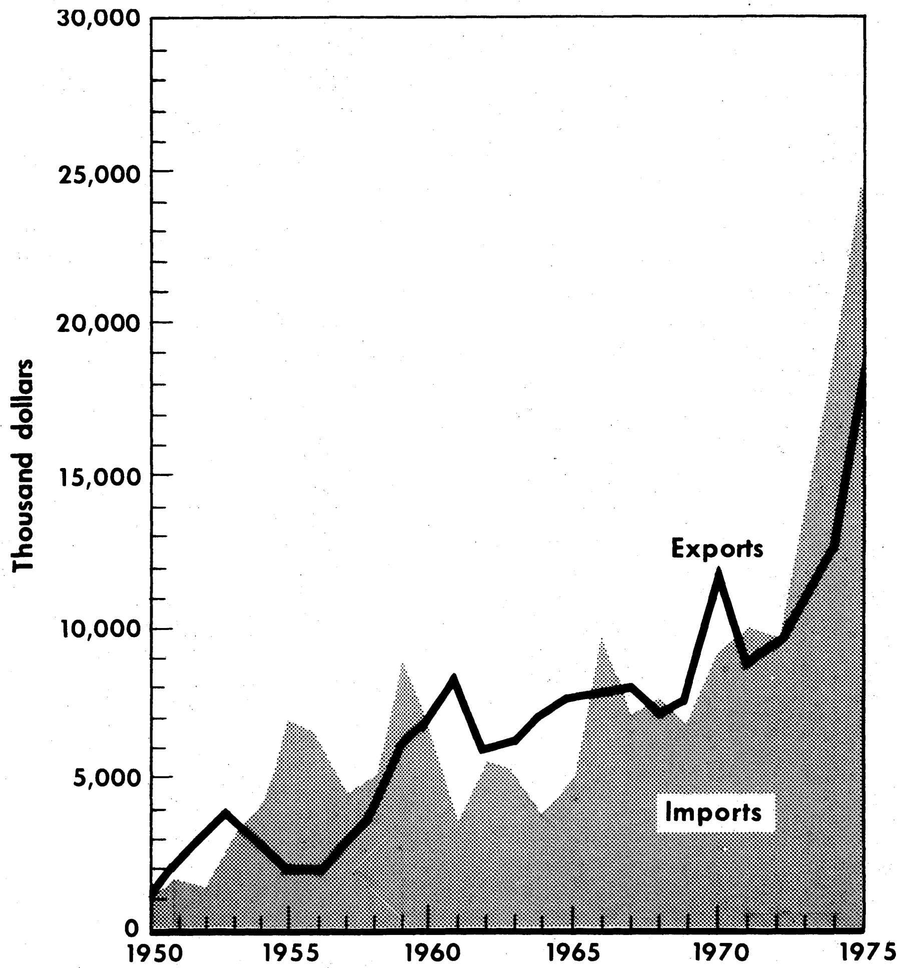

Figure 2.—Value of U.S. exports and imports of magnesia.

WORLD REVIEW

Greece.—The nation retained its status as a major world producer of crude and dead-burned magnesite. Exports of crude and dead-burned magnesite were 26,240 tons, valued at $1.2 million, and 407,925 tons, valued at $66 million, respectively.

The Financial Mining-Industrial & Shipping Corp. (FIMISCO) moved forward with a program for expansion, automation, and diversification of its refractories manufacturing activities which included the production of new types of refractory brick, installation of a tar impregnation unit, acquisition of a manufacturing license from the U.S. firm George P. Reintjes, Co., Inc., for special electric furnace roofs, and expansion and improvement of its ore-dressing facilities. FIMISCO anticipates completion of a new flotation plant to beneficiate low-grade magnesite and wastes in 1976 and a 50,000-ton-per-year vertical kiln for calcining bricks fabricated from flotation concentrates by 1979.

Table 7.—Magnesite: World production by country [1]
(Short tons)

Country	1973	1974	1975 p
North America: United States	W	W	W
South America:			
Brazil	303,392	403,072	e 413,000
Colombia e	2,000	2,000	2,000
Mexico	31,664	24,390	43,567
Europe:			
Austria	1,563,768	1,597,385	1,391,766
Czechoslovakia	643,749	698,865	729,729
Greece	1,177,626	1,508,818	1,572,032
Poland	24,361	26,235	29,957
Spain	r 264,363	292,454	e 300,000
U.S.S.R.e	r 1,880,000	r 1,910,000	1,980,000
Yugoslavia	422,966	510,932	534,620
Africa:			
Kenya	1,672	r e 11,000	18,519
Rhodesia, Southern e	22,000	22,000	22,000
South Africa, Republic of	88,393	115,317	67,464
Sudan e	110	110	110
Tanzania	120	e 55	e 55
Asia:			
China, People's Republic of e	1,100,000	1,100,000	1,100,000
India	r 300,931	292,699	345,023
Iran e 2	17,600	r 17,600	17,600
Korea, North e	1,900,000	1,900,000	1,900,000
Pakistan	3,714	3,163	e 2,390
Turkey	r 387,042	629,162	505,816
Oceania:			
Australia	r 25,597	23,631	e 18,000
New Zealand	1,273	911	e 880
Total	r 10,162,341	11,089,799	10,994,528

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data; not included in total.
[1] Figures represent crude salable magnesite. In addition to the countries listed, Bulgaria and Canada produce magnesite, but output is not reported and available information is inadequate to make reliable estimate of output levels.
[2] Year beginning March 21 of that stated.

In September 1975, the Government gave FIMISCO authorization for construction of a $50 million plant to recover magnesia from seawater and dolomite on Euboea. Initial annual plant capacity was planned for 100,000 tons of refractory-grade magnesia with a planned future expansion to 200,000 tons. Plant construction was expected to begin in 1976 and be completed in 1979. By 1979 FIMISCO was expected to diversify its refractory production to include tar-bonded dolomite and magnesite-dolomite brick and fired dolomite brick.

Macedonian Magnesite Mining-Industrial and Shipping Corp. planned construction of a third 70,000-ton-per-year-capacity rotary kiln. Magnomin General Mining Co., S.A. (subsidiary of General Refractories) began a $12 million investment program to increase its dead-burned magnesite capacity from 50,000 tons to 120,000 tons annually, and to produce about 22,000 cubic yards of insulating board from low-grade caustic-calcined magnesite by 1982.

Grecian Magnesite Ltd. was expanding and improving its mining, ore dressing, and sintering facilities at Gerakini, Chalkidiki, by installing a new rotary kiln and automatic ore sorters to increase production of caustic-calcined and dead-burned magnesite. Magnesite Mining Industrial and Commercial S.A. continued development of the Troupi mine in North Euboea and began installation of a rotary kiln for dead-burned magnesite and ore-dressing facilities for concentrates. Operation was expected to begin in mid-1976.

Pakistan.—Good-quality magnesite ore was produced from small mines in Baluchistan's Zhob District and near Abbottābā in the North West Frontier Province. The People's Republic of China (PRC) has conducted tests with ore from these mines and found it suitable for refractory brick manufacture. PRC technicians were preparing initial designs for a plant with a production capacity of 15,000 tons of brick per year.

Turkey.—Total reserves of magnesite were estimated at about 17 million tons.

Major deposits were located in Eskisehir, Konya, Denizli, Sivas, Erzincan, Kütahya, Mugla, and Bursa.

Yugoslavia.—The first Yugoslav plant for production of sintered magnesia from seawater was scheduled to be built at Bar, Montenegro. Magnochrome, the largest processor of magnesite in the country, will cover construction costs of about $570,000. The initial annual capacity will be 100,000 tons of sintered magnesia. Employment was expected to be 300 persons.

Seawater magnesia production facilities and capacities throughout the world by country follow:

Country	Location	Company	Capacity (short tons of MgO)
Canada	Aguathuna, Newfoundland	Lundrigan's Ltd	30,000
Ireland	Dungarvan, Waterford	Pfizer Chemical Corp	75,000
Israel	Arad	Dead Sea Works, Ltd	50,000
Italy	Syracuse, Sicily	Compagnia Generale de Magnesio S.p.A.	60,000
	Sant'Antioco, Sardinia	Sardamag S.p.A	120,000
Japan	Hotsu	Hokuriku Seien Kogyo K.K.	72,000
	Navetsu	Nihon Kasui Kako Co	55,000
	Minamata, Onohama, Toyama	Shin-Nihon Chemical Industries Co.	187,000
	Ube, Yamaguchi	Ube Chemical Industries	440,000
Mexico	Ciudad Madero, Tampico	Química del Mar SA	50,000
Norway	Heroya, Oslo Fjord	Norsk Hydro-Elektrisk Kvaelstof A/S.	80,000
People's Republic of China	Lianoning, Manchuria		10,000
U.S.S.R	NA		100,000
United Kingdom	Hartlepool County, Durham	Steetley, Ltd	250,000
United States	(1)	(1)	590,000
Total			2,169,000

[1] Seawater production facilities appear in tabulation shown in "Domestic Production" section of this chapter.
NA Not available.

TECHNOLOGY

A potential improvement in the operation of lime and limestone wet industrial scrubbers that requires modification of the scrubber solution chemistry was reported. A more reactive limestone (or lime) slurry was created by the addition of a major amount of soluble sulfate such as magnesium sulfate.[2]

Crushed magnesite ore associated with serpentine was treated with small quantities of diesel oil and cationic collector to activate the surfaces of the serpentine and other gangue minerals. Finely divided magnetite or ferrosilicon was added to the conditioned ore to increase the magnetic susceptibility of the gangue minerals. Application of magnetic separation provided a nonmagnetic magnesite fraction and a magnetic gangue fraction.[3]

[2] Chemical & Engineering News. Scrubber Chemistry Avoids Scale. V. 53, No. 19, May 12, 1976, p. 20.

[3] Frangiskos A., and T. Gambopoulos (assigned to Financial Mining-Industrial & Shipping Corp.). Magnetic Beneficiation of Magnesite Ore Which Is Associated With Serpentine. U.S. Pat. 3,929,627, Dec. 30, 1975.

Manganese

By Gilbert L. DeHuff [1]

Cuts in steel production at home and abroad resulted in substantially lower consumption of manganese alloys and metal in 1975. Although domestic consumption of manganese ore decreased somewhat, production of ferromanganese increased over that of 1974 owing to resumption of production by one of the country's two blast furnace producers of standard high-carbon alloy. Ferromanganese imports continued at a high level, but prices of the imported alloy dropped appreciably during the year. The General Services Administration (GSA) continued its sales of manganese ore surplus to the stockpile objective. There was neither production nor shipment of manganese ore, concentrate, or nodules, containing 35% or more manganese, in the United States in 1975.

Legislation and Government Programs.—Total Government sales of manganese stockpile excesses for the calendar year, as reported by GSA, were as follows in short tons (gross weight): Natural battery ore of stockpile grade, 43,694; synthetic dioxide, 50; type B chemical ore, 18,000; and metallurgical ore, 63,826 of stockpile grade and 409,991 of nonstockpile grade.

Government stockpile physical inventory changes for manganese items in calendar year 1975 consisted of the following: Stockpile-grade natural battery ore decreased 1,379 short tons to 252,072 tons; synthetic dioxide decreased 2,300 tons to 5,838 tons; type B chemical ore decreased 4,497 tons to 95,000 tons; metallurgical ore, stockpile grade, decreased 588,726 tons to 5,614,412 tons; metallurgical ore, nonstockpile grade, dropped 27,235 tons to 1,340,716 tons; high-carbon ferromanganese was down 54,566 tons to 607,478 tons; and electrolytic metal decreased by 25 tons to 14,171 tons.

Table 1.—Salient manganese statistics in the United States
(Short tons)

	1971	1972	1973	1974	1975
Manganese ore (35% or more Mn):					
Production (shipments)	142	578	239	--	--
Imports general	1,914,264	1,620,252	1,509,793	1,225,033	1,574,045
Consumption	2,155,454	2,331,459	2,140,058	1,880,176	1,818,983
Manganiferous ore (5% to 35% Mn):					
Production (shipments)	198,334	147,161	203,055	272,908	158,725
Ferromanganese:					
Production	759,896	800,723	683,075	544,361	575,809
Exports	4,526	6,842	8,574	7,011	32,300
Imports for consumption	242,778	348,539	390,591	421,222	397,212
Consumption	899,011	967,968	1,116,602	1,115,395	881,527

DOMESTIC PRODUCTION

For the second year in succession, there was neither production nor shipment of manganese ore, concentrate, or nodules, containing 35% or more manganese, in the United States. Ferruginous manganese ore containing 10% to 35% manganese was produced and shipped in New Mexico, and shipments continued from mine or mill

[1] Supervisory physical scientist, Division of Ferrous Metals.

stockpiles on the Cuyuna Range of Minnesota. Total shipments decreased 42% from those reported for 1974. No manganiferous iron ore containing 5% to 10% manganese was produced or shipped in either 1975 or 1974. Manganiferous zinc residuum continued to be recovered from New Jersey zinc ores.

Table 2.—Manganese and manganiferous ore shipped[1] in the United States, by State
(Short tons)

Type and State	1974		1975	
	Gross weight	Manganese content	Gross weight	Manganese content
Manganese ore (35% or more Mn, natural)	--	--	--	--
Manganiferous ore: Ferruginous manganese ore (10% to 35% Mn, natural):				
Minnesota	225,560	28,744	108,749	12,880
New Mexico	47,348	6,060	49,976	5,696
Total[2]	272,908	34,804	158,725	18,576
Value manganese and manganiferous ore	$2,323,254	--	$1,411,912	--

[1] Shipments are used as the measure of manganese production for compiling U.S. mineral production value. They are taken at the point at which the material is considered to be in marketable form for the consumer. Besides direct-shipping ore, they include, without duplication, concentrate and nodules made from domestic ores.
[2] There were no shipments of manganiferous iron ore containing 5% to 10% Mn, natural.

CONSUMPTION, USES, AND STOCKS

In the production of raw steel (ingots, continuous- or pressure-cast blooms, billets, slabs, etc., and including steel castings), consumption of manganese as ferroalloys, metal, and direct-charged ore, as reported to the Bureau of Mines by consumers, was 13.3 pounds per short ton of raw steel produced. Of this total, 11.4 pounds was ferromanganese; 1.6 pounds, silicomanganese; 0.03 pounds, spiegeleisen; 0.2 pound, manganese metal; and 0.02 pound, manganese ore (containing 35% or more manganese). The comparable 1974 total, on the same basis, was 13.3 pounds with ferromanganese at 11.5, silicomanganese at 1.4, spiegeleisen at 0.05, metal at 0.25, and ore at 0.1. In addition to the aforementioned consumption of manganese in 1975, there was consumed per short ton of raw steel produced approximately 1.3 pounds of manganese contained in manganese ore used in making pig iron or equivalent hot metal. The comparable figures for 1974 and 1973 were 1.2 and 1.1 pounds, respectively.

Producers of manganese ferroalloys and metal were caught between rising costs and competition from imports on the one hand and a lessened demand at stable or lower product prices on the other. A sharp drop in steel production was primarily responsible for the low demand, but aluminum and other markets were off along with the general economy. Pursuit of ongoing pollution control programs continued to add to both capital and operating costs, and rising energy costs made conservation of energy a matter for attention. Plant modernization looked forward to expected high demand in the not too distant future, and there was some conversion of furnaces from chrome to manganese alloy products.

Union Carbide Corp. early in the year consolidated its Ferroalloys Div. and its Mining and Metals Div. into a new Metals Div.

Table 3.—Consumption and industry stocks of manganese ore[1] in the United States
(Short tons)

	Consumption 1974	Consumption 1975	Stocks Dec. 31, 1975
By use:			
Manganese alloys and metal	1,415,563	1,440,243	1,570,571
Pig iron and steel	222,449	176,167	164,033
Dry cells, chemicals and miscellaneous	242,164	202,573	329,894
Total	1,880,176	1,818,983	2,064,498
By origin:			
Domestic	69,749	75,755	78,443
Foreign	1,810,427	1,743,228	1,986,055
Total	1,880,176	1,818,983	2,064,498

[1] Containing 35% or more manganese (natural).

Table 4.—Consumption, by end use, and industry stocks of manganese ferroalloys and metal in the United States in 1975
(Short tons, gross weight)

End use	Ferromanganese High carbon	Ferromanganese Medium and low carbon	Silico-manganese	Spiegel-eisen	Manganese metal[1]
Steel:					
Carbon	582,876	90,756	97,285	8,103	6,506
Stainless and heat resisting	4,043	2,541	5,808	3	4,030
Full alloy	81,623	23,060	29,192	615	833
High-strength low-alloy	57,541	9,792	7,505	--	640
Electric	313	149	775	--	2
Tool	1,581	218	15	--	247
Unspecified	455	364	2,657	--	--
Total steel	728,432	126,880	143,237	8,721	12,258
Cast irons	14,389	4,518	12,033	5,486	189
Superalloys	348	W	W	--	280
Alloys (excludes alloy steels and superalloys)	4,239	1,408	3,788	35	8,750
Miscellaneous and unspecified	363	950	1,501	--	932
Total consumption	747,771	133,756	160,559	14,242	22,409
Stocks, Dec. 31:					
Consumer	275,378	19,632	25,057	W	3,979
Producer	79,935	21,102	43,493	W	7,344
Total stocks	355,313	40,734	68,550	5,248	11,323

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified" where applicable.
[1] Virtually all electrolytic.

Electrolytic Manganese Metal.—All of the manganese metal produced domestically, and virtually all of that imported, was electrolytic metal. Virtually all of the metal consumed was electrolytic metal, but it appears that some low-carbon ferromanganese (such as "Massive Manganese" or "Gimel Metal") and some manganese-aluminum additives were erroneously reported by consumers as manganese metal. The metal that was used to make manganese-aluminum additives is included in table 4 under the "Alloys (excludes alloy steels and superalloys)" category. The additives are not knowingly included in the table, it being desired to report consumption at the metal rather than the additive level of the usage cycle.

The supply situation with respect to electrolytic manganese metal changed from one of shortage in 1974 to one of oversupply in 1975, necessitating severe production cuts. Production of electrolytic metal dropped appreciably to 22,141 short tons from 27,033 tons in 1974. Production was by the same three plants of the same three companies: Foote Mineral Co., New Johnsonville, Tenn.; Kerr-McGee Chemical Corp., Hamilton (Aberdeen), Miss.; and Union Carbide Corp., Marietta, Ohio. With completion of Kerr-McGee's expansion of productive capacity to 9,300 tons of metal per year, and an increase of about 10% in Foote's annual capacity to approximately 11,000 tons, total U.S. annual capacity was approximately 30,000 tons by midyear.

Ferromanganese.—Bethlehem Steel Corp., at Johnstown, Pa., and United States Steel Corp., at McKeesport, Pa., were the only domestic ferromanganese producers using blast furnaces. United States Steel resumed production at McKeesport in May after having sacrificed ferromanganese production for pig iron for a year or more previously. Electric furnaces were used to produce ferromanganese by six companies in eight plants: Airco Alloys Div., Airco Inc., Calvert City, Ky.; Ohio Ferro-Alloys Corp., Philo, Ohio; Roane Electric Furnace Co. (Engelhard Minerals & Chemicals Corp.), Rockwood, Tenn.; Satralloy Inc., Steubenville, Ohio; Tenn-Tex Alloy Corp. of Houston, Houston, Tex.; and Union Carbide Corp., Alloy, W. Va., Marietta, Ohio, and Portland, Oreg. Fused salt electrolysis continued to be used by Chemetals Div., Diamond Shamrock Corp., Kingwood, W. Va., to make low-carbon ferromanganese sold under the trade name of Massive Manganese. The company was engaged in doubling capacity of this plant to 17,000 short tons per year. Satralloy Inc. began producing high-carbon ferromanganese at the beginning of October in one of six furnaces at Steubenville, Ohio. This plant was formerly owned and operated by Foote Mineral Co., primarily for production of chromium ferroalloys. U.S. shipments of ferromanganese from furnaces totaled 556,000 short tons compared with 574,000 tons in 1974 and 779,000 tons in 1973.

Table 5.—Ferromanganese and silicomanganese produced in the United States and manganese ore [1] consumed in their manufacture

Year	Production: Ferromanganese: Gross weight (short tons)	Manganese content: %	Manganese content: Short tons	Silicomanganese (gross weight, short tons)	Manganese ore [1] consumed (gross weight, short tons): Foreign [2]	Domestic [2]	Per ton of ferromanganese made [3]	Per ton of ferromanganese and silicomanganese made [3] [4]
1971	759,896	78.6	597,205	165,000	1,820,408	7,033	2.4	1.9
1972	800,723	78.3	627,358	153,000	1,896,483	25,620	2.3	2.0
1973	683,075	78.8	538,119	184,000	1,648,806	25,912	2.4	1.9
1974	544,361	78.0	424,405	196,000	1,348,425	55,822	2.5	1.8
1975	575,809	78.9	454,309	143,000	1,389,300	48,011	2.4	1.9

[1] Containing 35% or more manganese (natural).
[2] Includes ore used in producing silicomanganese and metal.
[3] Includes ore used in producing silicomanganese.
[4] Ratio of ore consumed to ferromanganese produced if silicomanganese is considered a special grade of ferromanganese.

Table 6.—Manganese ore used in producing ferromanganese, silicomanganese, and manganese metal in the United States, in 1975, by source of ore

Source	Gross weight (short tons)	Mn content, natural (percent)
Domestic [1]	48,011	48
Foreign:		
Africa	563,005	47
Australia	86,738	48
Brazil	481,809	47
Cuba [1]	30,290	48
India	137,569	48
Mexico	26,106	39
U.S.S.R. [1]	46,234	47
Unidentified	17,549	51
Total	1,437,311	47

[1] Most, if not all, from U.S. Government surplus stockpile disposals.

The production reported in the various tables of this chapter is net production; that is, the quantity of ferromanganese produced for shipment outside the producing ferroalloy facility. It does not include the remelt material—fines, offgrade, or other ferromanganese output of the furnace—that was fed back to the furnace or lost in the plant, and which is included in gross data reported by the furnace operator. It does include ferromanganese made for use in the company's steel furnaces at the same or other locations.

Silicomanganese.—A large drop was recorded in production of silicomanganese in the United States to 143,000 short tons from 196,000 tons in 1974 and 184,000 tons in 1973. The silicomanganese figures represent net production produced for shipment. They do not include the silicomanganese that was produced for use as an intermediate for the production of medium- or low-carbon ferromanganese in the same plant. Silicomanganese shipments from furnaces were 126,000 tons in 1975, compared with 192,000 tons in 1974 and 196,000 tons in 1973. Six companies used eight plants to produce silicomanganese for shipment in 1975: Airco Alloys Div., Airco Inc., Theodore (Mobile), Ala.; Interlake Inc., Beverly, Ohio; Ohio Ferro-Alloys Corp., Philo, Ohio; Roane Electric Furnace Co. (Engelhard Minerals & Chemicals Corp.), Rockwood, Tenn.; Tenn-Tex Alloy Corp. of Houston, Houston, Tex.; and Union Carbide Corp., Alloy, W. Va., Marietta, Ohio, and Portland, Oreg. End-use consumption of silicomanganese—that is, consumption outside the ferroalloy plants—was 18.2% that of ferromanganese, compared with 15.9% in 1974 and 14.2% in 1973.

Spiegeleisen.—The New Jersey Zinc Co. continued to produce spiegeleisen in electric furnaces at Palmerton, Pa.

Pig Iron.—A total of 359,000 short tons of manganese-bearing ores containing over 5% manganese (natural) was consumed in the production of pig iron (or its equivalent hot metal). Domestic sources supplied 190,000 tons, of which 73,000 tons was manganiferous iron ore containing 5% to 10% manganese, 111,000 tons was ferruginous manganese ore containing 10% to 35% manganese, and 6,300 tons was manganese ore containing 35% or more manganese that was apparently obtained from GSA through its surplus stockpile disposal program. Foreign sources supplied 169,000 tons, of which 2,000 tons was manganiferous iron ore and 167,000 tons was manganese ore containing 35% or more manganese.

Battery and Miscellaneous Industries.—The ore reported in table 3 includes that consumed in making synthetic manganese dioxide by either electrolytic or chemical means, but it does not include consumption of the synthetic dioxide. Although some synthetic dioxide is used for chemical purposes, most of it is used in the manufacture of dry cell batteries, particularly for the manganese-alkaline type, premium or heavy-duty Leclanché (manganese dioxide-ammonium chloride-zinc) cells, and as a blend with natural ore in ordinary Leclanché cells.

The domestic ore and much of the foreign ore used for chemical and miscellaneous purposes did not meet national stockpile specification P-81-R for chemical-grade ore.

PRICES

Manganese Ore.—All manganese ore prices are negotiated, dependent in part on the characteristics and quantity of ore offered, delivery terms, and fluctuating ocean freight rates. Trade journal quotations reflect the paper's evaluation of the market. For 1975, contract prices for metallurgical manganese ore having a minimum manganese content of 47% to 48% manganese were $1.38 to $1.45 per long ton unit, c.i.f. U.S. ports. Although contracts for ore to be delivered the following year are normally negotiated in October or November, contracts for ore to be delivered in 1976 had not been made by yearend 1975.

Manganese Alloys.—The producer price for standard high-carbon ferromanganese, having a minimum manganese content of 78%, was maintained at $440 per long ton of alloy throughout the year. The price of imported alloy of the same grade, however, as quoted by Metals Week, dropped from $450–$460 at the beginning of the year, delivered at Pittsburgh and Chicago, to $440–$450 in March, to $410–$430 in May, and to $390–$415 for the last 2 months of the year.

Manganese Metal.—A dual price of 53/54 cents per pound prevailed throughout the year for standard or comparable grades of electrolytic manganese metal chips, f.o.b. producer plant, for shipments of 30,000 pounds or more.

FOREIGN TRADE

Exports of ferromanganese totaled 32,300 short tons valued at $10,601,354, compared with 7,011 tons valued at $2,203,957 in 1974. Of the 1975 total, Canada took 21,900 tons; West Germany, 3,360 tons; Sweden, 2,914 tons; the Netherlands, 1,381 tons; Romania, 1,084 tons; the United Kingdom, 460 tons; Turkey, 330 tons; Greece, 224 tons; Venezuela, 141 tons; Mexico, 107 tons; Brazil, 90 tons; the Republic of South Africa, 66 tons; Bolivia, 62 tons; Colombia, 58 tons; Ghana, 41 tons; France, 33 tons; Peru, 31 tons; Malaysia, 12 tons; and Italy, 6 tons. Exports classified as "manganese and manganese alloys, wrought or unwrought, and waste and scrap" totaled 3,256 tons valued at $3,318,222, compared with 2,318 tons valued at $2,118,803. This classification includes electrolytic manganese metal and manganese-copper alloys, but it does not include ferromanganese. Exports of ore and concentrate containing more than 10% manganese amounted to 204,523 tons valued at $13,886,100, compared with 223,088 tons valued at $13,-656,462 in 1974. Of the total, large quantities having relatively low average values were distributed as follows: Spain, 80,000 tons; Mexico, 41,000 tons; Canada, 27,000 tons; Yugoslavia, 14,000 tons; and the Republic of Korea, 11,000 tons. These tonnages appear to have been largely, if not entirely, metallurgical ore obtained from GSA sales of Government surplus stocks.

The average grade of imported manganese ore in 1975 was 49% manganese, compared with 48% in 1974 and 1973. Brazil supplied 40% of this ore in 1975; Gabon, 31%; the Republic of South Africa, 13%; and Australia, 11%. Imports of manganiferous ore (more than 10% but less than 35% manganese) consisted of 185 short tons from Mexico having an average manganese content of 34%.

Ferromanganese imports for consumption continued at a high level, although down somewhat from those of the preceding year. France and the Republic of South Africa continued to be the principal suppliers. Both are countries in which a U.S. company has a substantial interest in a ferromanganese producer. Silicomanganese imports for consumption totaled 54,723 short tons containing 35,156 tons of manganese. Sources and tonnages (gross weight) were as follows: Japan, 19,909; Norway, 16,128; the Republic of South Africa, 8,524; Yugoslavia, 4,795; Spain, 2,425; Brazil, 2,203; the Republic of Korea, 243; Canada, 203; Mexico, 183; and France, 110. Imports for consumption classified as unwrought manganese metal, except alloys, and waste and scrap, totaled 4,378 short tons, compared with 2,506 tons in 1974. Of the 1975 total, 3,332 tons were from the Republic of South Africa, 785 tons from Japan, 142 tons from Canada, and 119 tons from the United Kingdom.

Imports for consumption classified as "manganese compounds, other" totaled 1,394 short tons, compared with 3,086 tons in 1974 and 4,355 tons in 1973. The sources, gross weights, and values per pound in 1975 were as follows: Japan, 1,114 tons (32 cents); the United Kingdom, 191 tons (6 cents); Belgium, 60 tons (32 cents); West Germany, 28 tons (87 cents); and France, less than 1 ton ($2.41). The imports from Japan and Belgium appear to have consisted largely, if not entirely, of synthetic manganese dioxide. Manganese sulfate imports consisted of only 2½ tons from Japan.

Tariffs.—The duty on manganese ore from most nations remained suspended, while the statutory rate continued to be 1 cent per pound of contained manganese and continued to apply to ore from the U.S.S.R. and the People's Republic of China.

Table 7.—U.S. imports[1] of manganese ore (35% or more Mn), by country

Country	1974			1975		
	Gross weight (short tons)	Mn content (short tons)	Value (thousands)	Gross weight (short tons)	Mn content (short tons)	Value (thousands)
Australia	233,454	114,033	$8,136	171,146	86,541	$8,443
Brazil	463,763	222,000	15,105	633,076	307,367	30,012
Gabon	302,530	150,117	12,712	488,073	244,796	26,526
Ghana	9,850	4,531	425	--	--	--
Mexico	39,021	16,431	1,018	52,327	23,171	1,724
Morocco	51,210	27,506	3,081	--	--	--
South Africa, Republic of	73,602	32,909	3,222	206,013	92,211	9,663
Zaire	51,603	25,291	1,392	23,410	11,444	735
Total	1,225,033	592,818	45,091	1,574,045	765,530	77,103

[1] Quantities for general imports and imports for consumption were identical.

Table 8.—U.S. imports for consumption of ferromanganese, by country

Country	1974			1975		
	Gross weight (short tons)	Mn content (short tons)	Value (thousands)	Gross weight (short tons)	Mn content (short tons)	Value (thousands)
Belgium-Luxembourg	1,615	1,270	$603	3,483	2,675	$1,059
Brazil	1,598	1,230	258	6,228	4,787	2,136
Canada	10,397	7,987	2,844	952	702	167
France	212,439	164,898	42,340	138,999	107,058	45,127
Germany, West	2,420	1,949	976	827	689	730
India	15,000	11,239	3,053	5,977	4,557	1,301
Italy	1,103	911	334	--	--	--
Japan	29,107	22,501	9,257	73,851	56,111	27,584
Norway	9,498	7,431	2,191	22,891	17,371	6,723
Portugal	552	434	180	661	510	202
South Africa, Republic of	127,106	99,716	23,098	121,456	94,885	34,304
Spain	8,290	6,740	2,698	9,541	7,925	5,234
Sweden	1,932	1,445	542	--	--	--
Taiwan	165	123	52	11,243	8,507	3,502
United Kingdom	--	--	--	1	1	1
Yugoslavia	--	--	--	1,102	872	811
Total	421,222	327,874	88,426	397,212	306,650	128,381

WORLD REVIEW

A comprehensive background report on sea-floor manganese nodules, the technology for their recovery, the mining interests, legislative concerns and international considerations involved, was prepared as a source of reference for congressional activity with respect to a national policy for deep sea-floor mining.[2]

A Manganese Centre was formed early in 1975 by producers and consumers, with headquarters in Paris, to promote the consumption of manganese and to foster cooperation in research and dissemination of information. Founding members were Aciéries de Paris et d'Outreau, Compagnie Minière de l'Ogooué, Compañía Minera Autlan, Elkem-Spigerverket A/S, N. V. SADACEM, Société Europenne des Derives du Manganes (SEDEMA), Société Minière de Kisenge, South African Manganese Ltd., and Ugine Aciers.[3]

Old trade routes for manganese ore were reestablished when the Suez Canal was reopened in June 1975 after having been closed for 8 years.

[2] Mielke, J. E. Ocean Manganese Nodules. Congressional Research Service, Library of Congress, June 1975, 203 pp.

[3] Industrial Minerals (London). Manganese Ore: Supplies Adequate From a Choice of Sources. November 1975, p. 31.

Table 9.—Manganese ore: World production by country

(Short tons)

Country [1]	Percent Mn [e]	1973	1974	1975 [p]
North America:				
Mexico [2]	35+	401,268	444,379	472,295
United States	52	239	--	--
South America:				
Argentina	27–30	13,876	28,728	34,588
Bolivia [2 3]	28+	709	565	1,362
Brazil	38–50	[4] 1,779,893	[4] 1,971,597	[e] 1,800,000
Chile	38–42	15,911	31,631	22,064
Peru	27–33	8,574	1,801	1,800
Europe:				
Bulgaria	30–	42,000	37,500	38,600
Greece	50	6,859	8,763	8,168
Hungary	30–	[r] 207,257	148,150	201,023
Italy	27	28,074	15,441	--
Portugal	37–40	206	78	--
Spain	30	[r] 7,487	--	--
U.S.S.R. [5]	35	[r] 9,089,000	9,370,000	9,700,000
Yugoslavia	30+	10,712	14,641	18,657
Africa:				
Angola	30+	5,161	--	--
Botswana	30+	375	9	--
Egypt	35+	2,961	5,453	3,983
Gabon	50–53	2,115,105	2,274,957	2,458,151
Ghana	32–50	350,768	275,856	457,792
Morocco	53	161,102	192,662	144,344
South Africa, Republic of	30+	4,602,839	5,230,886	6,359,262
Zaire	35–55	368,131	317,172	340,090
Asia:				
Burma	NA	308	[e] 310	--
China, People's Republic of [e]	30+	1,100,000	1,100,000	1,100,000
India [6]	10–54	[r] 1,641,000	1,595,000	1,687,637
Indonesia	47+	17,731	15,227	15,290
Iran [7]	33+	24,200	33,100	39,700
Japan	27–45	[r] 207,970	183,621	174,089
Korea, Republic of (South)	40	1,897	2,323	3,483
Pakistan	35–	[r] 67	8	85
Philippines	52	4,379	945	--
Thailand	46–50	40,034	33,279	27,462
Turkey	35+	2,815	3,571	20,544
Oceania:				
Australia	37–53	1,678,164	1,677,704	1,713,992
New Hebrides	42–44	33,215	52,151	51,279
Total	NA	[r] 23,970,287	25,067,508	26,895,740

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] In addition to the countries listed, Colombia, Cuba and the Territory of South-West Africa may have produced manganese ore and/or manganiferous ore, but available information is inadequate to make reliable estimates of output levels. Low grade ore not included in this table has been reported as follows in short tons: Czechoslovakia (about 17% Mn) 1973—1,100; 1974—1,072; 1975—1,101; Malaysia (apparently a manganiferous ferruginous ore; 28% to 30% Mn, 18% Fe in 1975; unspecified in 1973 and 1974) 1973—31,246; 1974—93,985; 1975—146,947; Romania (about 22% Mn) 1973—155,000; 1974—155,000; 1975—155,000; Republic of South Africa (15–30% Mn, in addition to material listed in table) 1973—73,333; 1974—98,769; 1975—123,131; Turkey (under 35% Mn) 1975 only—16,865.

[2] Estimated on basis of reported contained manganese.

[3] Exports.

[4] Figures are the sum of: 1) sales of direct shipping manganese ore, and 2) production of beneficiated ore, both as reported in the 1974 and 1975 editions of Anuario Mineral Brasileiro.

[5] Source: The National Economy of the U.S.S.R., Central Statistical Administration, Moscow. Grade represents the annual averages obtained from reported metal contents for the gross weights shown in the table.

[6] Of total 1973 output, 64% graded below 35% Mn, and 36% exceeded that grade. Comparable production breakdown for 1974 and 1975 not available, but 71% of 1974 total exports of 1,140,453 short tons were below 35% Mn.

[7] Iranian calendar year beginning March 21 of year stated.

Argentina.—Yacimientos Mineros Agua de Dionisio (YMAD), the state mining company, was reportedly developing the manganese-silver-gold deposits of Catamarca Province with expectations for production to begin in the second half of 1976.[4] These deposits have been under investigation since 1948.

Australia.—Manganese nodules containing iron, copper, nickel, uranium, and gold were found by the Royal Australian Navy at a depth of several hundred meters off Cape Leeuwin, Western Australia, over an area of 230,000 square miles.[5] ESB Inc.

[4] American Metal Market. V. 82, No. 240, Dec. 11, 1975, p. 9.

[5] American Metal Market. News Briefs. V. 83, No. 28, Feb. 10, 1976, p. 2.

has joined with Century Storage Battery Co., Ltd., to form Ray-O-Vac Australia, Pty., Ltd., for the production and marketing of Ray-O-Vac dry cell batteries.

Brazil.—In addition to its premium pellets typically analyzing 58% manganese, Indústria e Comércio de Minerios, S.A. (ICOMI), offered the following grades of metallurgical manganese ore from the Serra do Navio (Amapá) deposits in 1975: 3- by ½-inch high-grade lump, typically analyzing 49% manganese, 5.5% iron, 2.5% silica, 5.5% alumina, 0.09% phosphorus, and 5.0% moisture; ½- by 5/16-inch screened ore containing 46% to 48% manganese for direct addition to blast furnace feed; and fines, typically analyzing 44% manganese and sized to 5/16 inch by 20 mesh, for sintering by the customer before addition to the blast or electric furnace. ICOMI is jointly owned by CAEMI S.A. (51%) and Bethlehem Steel Corp. (49%). The ores and pellets are shipped out of the port of Santana on the north bank of the Amazon River delta a few miles west of the small town of Macapa, Amapá Territory. The outloadings are typically on vessels of 15,000 to 25,000 tons, although vessels of 45,000 tons can be loaded. The pellet plant has enabled the utilization of previously unsold fines and low-grade ores.[6]

Late in 1975, ICOMI entered into an agreement with the Brazilian Government to limit exports of high-grade ore and pellets to 1.3 million tons per year, the average for exports over the last decade. With known reserves sufficient for only another 10 years at the present rate of production, and no large new Brazilian deposits of high-grade ore as yet proved, the Government has become concerned for future supplies of manganese for the country's growing steel industry. At the same time, a critical balance of payments deficit requires exports as an exchange earner. In this connection, it was reported that the Government would not approve export contracts for 1976 without a price increase. ICOMI, believed to be the only exporter in 1975, received slightly more than $50 per ton for its ore during the year. Because ocean freight rates dropped, the company hoped that it might achieve a higher price in 1976 without any cost increase to its customers.[7]

The Brazilian Government increased its prospecting efforts for manganese ore and was also conducting research looking toward utilization of the country's low-grade ores.[8] The National Mineral Production Department, Mines and Energy Ministry, announced the discovery of a large deposit of high-grade manganese ore near the Venezuelan border in the Uaupés district about 25 miles from the Rio Negro, a navigable tributary of the Amazon. The size of the deposit was estimated at 28 to 33 million tons of ore, and grades of 47% to 51% manganese were reported.[9]

In 1974, Brazil imported 13,000 tons of manganese ore and 367 tons of metal compared with 9,900 tons and 270 tons, respectively, in 1973.

Canada.—The two principal consumers of metallurgical manganese ore in 1974 were Chromasco Ltd. and Union Carbide Canada Ltd.,[10] both located at Beauharnois, Quebec. Ferromanganese production by Union Carbide was adversely affected by a strike that lasted from January 19 into July, although some production and shipments continued during the period.

Chile.—Manganese ore produced in 1975 had an average manganese content of 38.7%. Production of ferromanganese was 8,200 tons; silicomanganese, 3,000 tons.

Gabon.—Battery and chemical ore produced in 1975 totaled 44,000 tons.

Greece.—Concentrates produced in 1975 had a manganese content of 49% to 50%. Exports of pyrolusite in 1974 were 6,200 tons, of which 3,000 tons went to France, 2,800 tons to West Germany, and 400 tons to other countries. In 1975, at the gravity concentration plant at its Drama manganese mine, Financial Mining-Industrial & Shipping Corp. (FIMISCO) (Scalistiri Group) produced 8,300 tons and exported 7,700 tons of battery-grade manganese concentrate.

Indonesia.—More than 3,300 people were employed in the production of manganese ore in 1974. These labor-intensive,

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[6] Parfet, H. B. Manganese for Steelmaking: A Crisis of the Future? Iron and Steelmaker, v. 2, No. 1, January 1975, pp. 18–23.

[7] Yolen, S. Icomi, Brazil Agree To Limit Exports of High-Grade Ore. Am. Metal Market, v. 83, No. 16, Jan. 23, 1976, p. 12.

[8] American Metal Market. Brazil Aims to Intensify Icomi Manganese Probes. V. 82, No. 93, May 13, 1975, p. 9.

[9] American Metal Market. Find Manganese Ore Near Brazil Border. V. 82, No. 108, June 4, 1975, p. 37.

[10] Johnson, R. F. Manganese—1974. Mineral Development Sector. Department of Energy, Mines and Resources, Ottawa, Canada, July 1975, 8 pp.

low-capitalization operations, with poor safety records, were by numerous small firms in Central Java and in the Jogjakarta area. Exports in 1974 totaled 17,600 tons. The distribution of this manganese dioxide ore, with the manganese dioxide content, was as follows: Japan, 10,000 tons (70% to 80%) plus 4,000 tons (60% to 70%); Taiwan, 2,600 tons (70% to 80%); and Europe, 1,000 tons (80% to 90%). Small quantities were consumed domestically for the manufacture of dry cell batteries. In 1975, demand was slack and miners were unable to sell their full production. Foreign investors were excluded from participation in manganese mining operations on Java, Madura, and Bali.

Italy.—Production of high-carbon ferromanganese in 1974 was 77,400 tons, while that of refined grades of ferromanganese was 10,800 tons. The respective quantities for 1973 were 67,000 and 11,900 tons. Imports of manganese ore in 1974 totaled 340,000 short tons. Of this quantity, 169,000 tons came from Gabon and 130,000 tons were from the Republic of South Africa. The National Association of Italian Steel Industries estimated that 354,000 tons of manganese ore were consumed by the industry in 1974.

Japan.—Production of ferromanganese in 1975 was 717,000 tons; silicomanganese, 480,000 tons; electrolytic manganese metal, 9,111 tons; and synthetic manganese dioxide, 45,764 tons. The manganese ore produced in 1975 had an average manganese content of 26.9%, except for 72 tons of dioxide ore averaging 69.2% manganese dioxide.

Mexico.—Proven reserves of manganese ore at the Molango deposit of Cía. Minera Autlan, S.A. de C.V., were estimated to be 13,800,000 tons in 1975. Possible and probable reserves were estimated to be on the order of 220 million tons over an area of approximately 375 square miles.[11] The ore, consisting of manganese, calcium, magnesium, and iron carbonates, is of marine sedimentary origin. The company calcines and nodulizes it in a rotary kiln, using natural gas, to produce a nodule product, the manganese and iron of which is in the lowest state of oxidation (MnO and FeO). Analyses for crude ore and for nodules were presented as follows, in percent:

	Mn	Fe	SiO_2	CaO	MgO	P	H_2O
Carbonate ore	27.7	5.9	9.0	5.6	7.0	XX	XX
Oxide nodules	39.6	8.2	13.5	7.8	10.0	0.06	<1

XX Not applicable.

In 1975, the annual capacity of the calcining and nodulizing operation was being increased to 500,000 tons from 365,000 tons, with completion scheduled for late 1976. In January 1974, the manganese ferroalloy producer, Ferroaleaciones Teziutlán with two plants in the Teziutlán municipal district, State of Puebla, was merged into Cía. Minera Autlan to form a ferroalloy division. Installed capacity of the two plants, Aire Libre and Copper, was 41,000 kilovolt-amperes with four furnaces at each plant. During 1975, construction proceeded on the company's new ferromanganese plant at Tamós in the municipal district of Pánuco, State of Veracruz, 12 miles from the port of Tampico. Two closed furnaces of 33,000 kilovolt-amperes will produce 110,000 tons per year. The first furnace was expected to come onstream in the first quarter of 1976; the second furnace, in the third quarter.[12] Also in 1975 at the Molango deposit, the company began development leading to conversion of its Tetzintla open pit operation to an underground mine. Of the 365,000 tons of nodules produced in 1974, 71% were exported.

Peru.—The only manganese production in 1974 was from the Japanese-owned Minas de Gran Bretaña. The average manganese content was 31%.

Portugal.—Eurominas Electrometalurgica SARL, a subsidiary of Pechiney Ugine Kuhlmann, brought onstream a new ferromanganese plant reported to be capable of producing 110,000 tons per year. According to preliminary data, 22,500 tons of manganiferous iron ore were produced in Portugal in 1975, averaging 41.4% iron and 8.7% manganese.

South Africa, Republic of.—South Afri-

[11] Galvan, L. Manganese Nodulizing Kiln Operation. Pres. at Am. Min. Cong. Conv., San Francisco, Calif., Sept. 28–Oct. 1, 1975, AMC Preprint, 11 pp.
[12] Work cited in footnote 11.

can Manganese Ltd. and Amcor Ltd. merged on April 1, 1975, forming South African Manganese Amcor Ltd.[13] South African Manganese has been, and continues to be, the Republic's principal producer of manganese ore, its contribution being estimated at more than 50% of the country's total production in 1974. The company's production in 1974 and 1975 was from four mines in Cape Province: Wessels, reputedly the world's largest underground manganese mine; Hotazel, now nearly mined out; Mamatwan; and Lohathla. Associated Manganese Mines of South Africa Ltd. continued to be the country's second largest producer. Other important producers in 1974 were Consolidated African Mines Ltd.; Marble Lime & Associated Industries, Ltd. (Gopani mine); National Manganese Mines (Pty) Ltd.; Rio Rita Mines (Pty) Ltd.; Roodepan Manganese Corp. (Pty) Ltd.; and Rooi Riet Base Metals (Pty) Ltd. During 1975, United States Steel Corp. acquired a 19% interest in Associated Manganese Mines of South Africa as part of an agreement involving procurement of iron ore from Associated's large reserves.

United States Steel's interest in Feralloys Ltd., a ferromanganese-producing subsidiary of Associated Manganese, was 44% according to United States Steel's 1975 Annual Report. The previously announced expansion program of Feralloys Ltd. was reported by Associated Manganese to be progressing satisfactorily with completion expected in the first half of 1977. Associated Manganese estimated that the capital requirements of its program for increasing manganese ore production in 1976 would be approximately $3,500,000.

Total production of the various grades of metallurgical ore in 1975 and 1974 was as follows, in short tons (1974 in parentheses): 30% to 40% manganese, 4,268,000 (3,336,000); 40% to 45%, 257,000 (291,000); 45% to 48%, 1,520,000 (240,000); and over 48%, 219,000 (1,254,000). Similarly, of the chemical ore produced: 35% to 65% manganese dioxide, 87,000 (103,000) tons; 65% to 75% manganese dioxide, 8,000 (6,000) tons. Production of ferruginous manganese ores containing 15% to 30% manganese and 20% to 35% iron was 123,000 tons and 99,000 tons, respectively. Local sales and exports of the various grades in 1974 were as follows (exports in parentheses): Metallurgical 30% to 40% manganese, 550,000 (3,007,000) tons; 40% to 45% manganese, 86,000 (206,000) tons; 45% to 48% manganese, 100,000 (254,000) tons; and over 48% manganese, 270,000 (1,055,000) tons; chemical 35% to 65% manganese dioxide, 104,000 (zero) tons; and 65% to 75% manganese dioxide, 8,000 (948) tons; and ferruginous, zero (129,000) tons. Production of ferromanganese in the 1974 fiscal year (October 1, 1973 to September 30, 1974) was 355,000 tons, compared with 273,000 tons in fiscal 1973.

Thailand.—Production of battery-grade manganese ore (75% manganese dioxide) in 1975 was 4,000 tons, while exports totaled 1,000 tons. Chemical ore production (75% manganese dioxide and up) was 926 tons; exports, 220 tons. The metallurgical ore produced ranged in manganese content from 46% to 50%.

U.S.S.R.—The Soviet Union asked at least two United States producers of ferroalloys, also Western European companies, for bids on a ferromanganese plant of sufficient size to produce 1.1 million tons per year of high-carbon ferromanganese. The target date for completion was 1980.[14]

Upper Volta.—A 5-nation, 14-firm consortium was formed to develop the Tambao manganese deposit. The Government of Upper Volta and a group of 11 Japanese firms, including Mitsui & Co., Ltd., Japan Metals & Chemicals Co. Ltd., Nippon Kokan, K.K., Nippon Denko Co., Ltd. and Kobe Steel Ltd., appeared to be the prime movers in the venture at midyear. The other participants were Union Carbide Corp., the only U.S. interest; the West German firm, Exploration und Bergbau GmbH; and the French firm, Soc. du Manganese.[15] Reserves were estimated at 13 million metric tons of ore.[16] Earlier lower tonnage estimates, made subsequent to test drilling about 1967, had estimated the grade to range from 44% to more than 54% manganese. Construction of 220 miles of railroad to the present railhead at Ougadougou was expected to begin before

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[13] Mining Journal (London). Samangan. Similar Manganese Shipments Expected. V. 286, No. 7346, June 4, 1976, p. 467.

[14] American Metal Market. Soviet Union Solicits Bids on Giant Ferroalloy Pact. V. 82, No. 68, Apr. 8, 1975, p. 1.

[15] American Metal Market. 5 Nations Tied to Upper Volta Manganese Deal Plan Joint Co. V. 82, No. 108, June 4, 1975, p. 4.

———. Set May 13 Talks in Manganese Venture. V. 82, No. 89, May 7, 1975, p. 8.

[16] American Metal Market. 14-Firm International Consortium To Mine Manganese in Upper Volta. V. 82, No. 41, Feb. 28, 1975, p. 6.

yearend. Export will be from Abidjan, Ivory Coast, 700 miles by rail from Ougadougou.

Zaire.—Société Minière de Kisenge, formerly owned by the Belgian firm, Bécéka-Manganèse, was wholly owned by the Zairian Government in 1975. Of 188,000 tons of crushed ore produced in 1975, 7,000 tons were carbonate ore. Ore exports were 141,000 tons before the civil war in Angola closed the Benguela Railway by which ore was shipped through Angola to the port of Lobito. Economics will not permit shipment by any other route, and exports were not resumed although production and stockpiling at the mine continued.

ESB-Zaire S.P.R.L., in which ESB Inc., Philadelphia, Pa., has a 75% interest, completed construction of a dry cell manufacturing facility about the beginning of 1975.

TECHNOLOGY

Extensive tests on the use of low concentrations of the manganese organometallic, methylcyclopentadienyl manganese tricarbonyl (MMT), as an antiknock additive for unleaded gasoline were claimed by the producer, Ethyl Corp., to be economically attractive without significant adverse effects on car operation or exhaust emissions. At the maximum recommended concentration of 0.125 gram of contained manganese per gallon of gasoline, the octane rating could be raised approximately 2 points. This would provide a crude oil savings of about 1% compared with conventional processing methods used to achieve the same octane numbers. It was estimated that atmospheric manganese concentrations resulting from widespread use on freeways would be less than 1 microgram per cubic meter except under the most unfavorable weather conditions; median airborne concentration in urban areas would be 0.05 microgram per cubic meter. No catalyst plugging was observed under typical driving conditions; exhaust valve and spark plug life presented no problems at the recommended low concentrations.[17] Ethyl Corp.'s 1975 Annual Report stated that sales of MMT increased sharply and that 27 refiners were using it.

A study by the U.S. Environmental Protection Agency (EPA) of the possible environmental effects of the use of MMT in gasolines led to the conclusion that it would not present a "direct disbenefit" to public health, but that its effect on emissions other than manganese was not clear. Many of the EPA tests used concentrations of MMT greater than 0.125 gram per gallon of gasoline, the maximum recommended by Ethyl Corp.[18]

Experimental work by Mobil Research and Development Corp., Paulsboro, N.J., suggested that sea-floor manganese nodules from the Pacific Ocean would be a good absorbent for removing metals from petroleum residua and heavy oils. At relatively high temperatures (850° F), the metals deposit on the surface of the nodules and the demetallized oil can be processed conventionally to provide low-sulfur fuel oil, gasoline, or home-heating oil. It was suggested that an operation of this type could prove useful for processing the high-metal asphaltic heavy oils of California, Canada, and Venezuela.[19]

A study by Ledgemont Laboratory, Kennecott Copper Corp., Lexington, Mass., of various metallurgical processes for use on sea-floor manganese nodules suggested that one or more of the three following processes could be ready for commercialization after scale-up of equipment: Reduction and ammoniacal leaching, sulfuric acid leaching, and hydrochloric acid reduction and leaching. The ammoniacal leach process is similar to the Caron process that was used for Nicaro nickel laterite ores in Cuba; the high-pressure sulfuric acid leach process is based on the process that was used by Freeport Sulfur Co. on laterites at Moa Bay, Cuba; and the low-pressure hydrochloric acid leach process is the one that has been proposed by Deepsea Ventures, Inc. Only the low-pressure hydrochloric acid leach process requires recovery of manganese in addition to nickel, copper, and cobalt for its success, although a manganese "add-on option" is

[17] Faggan, J. E., J. D. Bailie, E. A. Desmond, and D. L. Lenane. An Evaluation of Manganese as an Antiknock in Unleaded Gasoline. Pres. at Automobile Engineering Meeting, Soc. of Automotive Engineers, Detroit, Mich., Oct. 13, 1975, SAE preprint 750925, 43 pp.

[18] Moran, J. B. The Environmental Implications of Manganese as an Alternate Antiknock. Pres. at Automobile Eng. Meeting, SAE, Detroit, Mich., October 1975, SAE preprint 750926, 55 pp.

[19] The Northern Miner (Toronto). V. 16, No. 27, Sept. 18, 1975, p. 7.

possible for the other processes. Nickel, copper, and cobalt do not occur as discrete minerals in the nodules, but are contained in the manganese oxides: Todorokite, birnessite, and delta MnO_2. A feature of the nodules is their extremely fine porosity of nearly 60% by volume. The comment was made that, because of intense competition, "proprietary process work must be well ahead of published information." Certain other processes, such as carbonyl chemistry, and the sulfur dioxide, nitric acid, and ferric chloride leaching processes, were not discussed primarily for lack of published material. An extensive bibliography and patent list was presented.[20]

Since February 1973, by extensive recycling of steelmaking slags from its basic oxygen furnace and open hearth shops to its blast furnaces, Inland Steel Co. was able to recover a large quantity of manganese and greatly reduce its use of manganese-bearing ores. By providing a calcined lime, Inland Steel reduced the amount of raw flux required per ton of hot metal, and more hot metal was produced per ton of iron ore consumed. The principal disadvantages resulting from this practice were the buildup of phosphorus and chromium in the hot metal when large quantities (300 pounds of slag per short ton of hot metal) were used in the blast furnace burdens. Both of these elements adversely affect steelmaking operations and product quality, although steelmaking practices can be adjusted to handle the increased phosphorus. The average chemical analysis for these slags during the period August 21 to December 31, 1974, was as follows: Iron, 26.29%; manganese, 4.17%; phosphorus, 0.367%; sulfur, 0.160%; chromium, 0.27%; lime (CaO), 31.75%; magnesia (MgO), 7.47%; alumina (Al_2O_3), 2.30%; and silica (SiO_2), 13.13%.[21]

Several papers were presented at the 34th Ironmaking Conf., American Institute of Mining, Metallurgical, and Petroleum Engineers, Toronto, Canada, April 1975, on the use of processes other than manganese for control of sulfur in the iron-steelmaking cycle. Desulfurization of the hot metal by use of calcium carbide or various forms of magnesium was discussed.

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[20] Agarwal, J. C., N. Beecher, D. S. Davies, G. L. Hubred, V. K. Kakaria, and R. N. Kust. Processing of Ocean Nodules—A Technical and Economic Review. Pres. at 104th Ann. Meeting, AIME, New York, Feb. 17, 1975, 25 pp.

[21] Joseph, R. W., and M. Haddad. Utilization of Steelmaking Slags in Blast Furnace Burdens. Pres. at 58th Nat. Open Hearth and Basic Oxygen Steel Conf., AIME, Toronto, Canada, April 1975, 15 pp.

Mercury

By Harold J. Drake [1]

Production of primary mercury totaled 7,366 flasks [2] valued at an estimated $912,227. Production was reported from 13 mines in California, Nevada, and New York. The threefold increase in output over that of the preceding year was accounted for principally by the opening of a new mine in Nevada.

Secondary production, including 500 flasks disposed of in January by the General Services Administration (GSA), declined 3% to 8,038 flasks.

Consumption declined 15% to 50,838 flasks. Declines by use ranged from 10% to 26% in major applications, with a 14% decline in use in electrical apparatus accounting for the largest loss in terms of volume. Usage in mildew-proofing paint was the only application reporting an increase. For most uses, the consumption declines prevalent in 1974 were reversed by the end of the second quarter of 1975 as consumption began to increase.

Consumer and dealer stocks rose 31% to 20,691 flasks, and producer stocks advanced 18% to 4,858 flasks.

Prices continued to decline, and by yearend, reached $117 per flask in New York and $77 per flask in London. The average U.S. price per flask for the year was $158.12 compared with $281.69 per flask in 1974.

Exports and reexports, at 494 flasks, were up only slightly from the 1974 level. Imports for consumption fell moderately to 43,865 flasks, a level 16% below that of the preceding year. Of the principal foreign suppliers, Canada, Mexico, and Spain recorded the greatest declines, but Italy recorded an eight-fold increase in shipments. The share of the U.S. market supplied by imports dropped to about 87% in 1975.

World production in 1975 totaled 251,226 flasks as reduced output was recorded in most countries. Some of the world's principal mercury producers formed an international association to promote the use of mercury and to attempt to stem the downtrend in prices. Countries originally represented included Spain, Italy, Yugoslavia, Turkey, Peru, and Algeria. Articles and provisions of the association were signed in April, and unsuccessful attemps were made thereafter to maintain a minimum flask price at various levels.

Legislation and Government Programs.—Government financial assistance on a participatory basis was available for mercury exploration projects through the Office of Minerals Exploration, U.S. Geological Survey, to the extent of 75% of the acceptable costs. No contracts were executed during 1975. GSA offered for sale 500 flasks of mercury monthly during 1975 but sold only the January offering.

The Federal Government concluded its hearings on the use of phenylmercury compounds in paints. During the hearings, the Environmental Protection Agency (EPA) attempted to prove that the phenylmercurics in paint were converted to environmentally hazardous methylmercury compounds, whereas paint manufacturers offered testimony that microorganisms demethylated methylmercury into inorganic mercury and methane gas thereby negating the harmful effects of methylmercury.

EPA proposed strict regulations to fine companies for discharging or spilling hazardous substances, such as mercury compounds, above specified levels. In the case of mercury compounds, the level was set at 1 pound or more. The maximum fine for each discharge or spill was set at

[1] Physical scientist, Division of Nonferrous Metals.

[2] Flask as used throughout this chapter refers to the 76-pound flask.

$500,000 but fines of more than $5,000 would be applied only if gross negligences were proven. Additional penalties would be applied for failures to notify EPA or local authorities of such discharges. The new regulations do not apply to companies having discharge permits issued by EPA or State authorities.

On March 14, EPA proposed National Interim Primary Drinking Water Regulations and held hearings, thereafter, on the proposed regulations. In addition, comments and information were received from representatives of State agencies, public interest groups, and others. The regulations proposed maximum contaminant levels in public drinking water and set the mercury level at 0.002 milligram per liter.

EPA published a study intended to determine the amount of mercury entering the environment and the manner in which it is redistributed, particularly with regard to its introduction into man's food chain.[3]

Congress has taken no action on authorizing the release of the 157,405 flasks of surplus mercury in the strategic stockpile. As of December 31, 1975, total strategic stockpile accumulations from all programs remained at 200,062 flasks.

Table 1.—Salient mercury statistics

	1971	1972	1973	1974	1975
United States:					
Producing mines	56	37	24	12	12
Production flasks	17,883	7,349	2,227	2,189	7,366
Value thousands	$5,229	$1,604	$637	$617	$912
Exports flasks	7,232	400	342	466	839
Reexports do	--	563	--	--	155
Imports:					
For consumption do	28,449	28,834	46,026	52,180	43,865
General do	29,750	29,179	46,076	52,102	44,472
Stocks, Dec. 31 do	16,862	15,708	17,946	19,877	25,549
Consumption do	52,257	52,907	54,283	59,479	50,838
Price: New York, average per flask	$292.41	$218.28	$286.23	$281.69	$158.12
World:					
Production flasks	300,634	278,968	r 270,014	r 260,964	251,226
Price: London, average per flask	$282.46	$203.01	$273.54	$267.94	$130.11

r Revised.

DOMESTIC PRODUCTION

Production of primary mercury amounted to 7,366 flasks. Twelve mines recorded production in 1975, the same number as in 1974. Byproduct mercury continued to be produced at a gold mine in Nevada and a zinc smelter in New York. Mercury mine production was reported from California and Nevada only. Mines known to have produced mercury in 1975 included the Guadalupe, Manhattan-One Shot, the Oat Hill, the Knoxville, and the New Almaden in California and the Red Bird and McDermitt in Nevada.

On June 2, Placer Amex, Inc. formally opened its new McDermitt open pit mine near the site of the old Cordero mine in Humboldt County, Nev. The new mining facility has a designed production capacity of 20,000 flasks per year and a reserve of about 400,000 flasks in ore averaging about 10 pounds of mercury per ton. The plant has been carefully designed to comply with EPA's mercury emission standard of 5.1 pounds per day. Disposal of tailings in an environmentally acceptable manner is accomplished by impoundment behind impervious dams in ponds with impervious bottoms. The company is required to maintain monitoring wells to determine if any mercury escapes from the ponds.

The results of an examination of the Kolmakof mercury deposit in Southwestern Alaska were published.[4] Although the possibility of significant mineralization exists in the area, it was concluded that the Kolmakof deposit was small.

The average grade of all ore processed in 1975, including ore treated in concen-

[3] U.S. Environmental Protection Agency. Materials Balance and Technology Assessment of Mercury and Its Compounds on National and Regional Bases. EPA-560/3-75-007, 1975, 400 pp.

[4] Merrill, C. W. Jr., and R. P. Maloney. Kolmakof Mercury Deposits. BuMines OFR 21-75, 1975, 21 pp.; available for consultation at the Bureau of Mines Library in Juneau, Alaska; the Central Library, U.S. Department of the Interior, Washington, D.C.; and the National Technical Information Services, Springfield, Va., PB 226 723.

trators, increased to 6.8 pounds of mercury per ton. Much of the increase was accounted for by the new McDermitt mine in Nevada.

Production of secondary mercury exclusive of GSA sales, totaled 7,538 flasks, a level 27% above that of 1974. Major sources of secondary mercury were industrial and control instruments, batteries, sludges, and dental amalgams.

Table 2.—Mercury produced in the United States, by State

Year and State	Producing mines [1]	Flasks	Value [2] (thousands)
1974			
Alaska	1	[3]124	$35
California	9	1,311	370
Nevada and New York	2	754	212
Total	12	2,189	617
1975			
California	8	878	174
Nevada and New York	4	6,488	738
Total	12	7,366	912

[1] Mercury mines only.
[2] Value calculated at average New York price.
[3] Includes 54 flasks of mercury estimated to be contained in cinnabar concentrate for export.

Table 3.—Mercury ore treated and mercury produced in the United States [1]

Year	Ore treated (short tons)	Mercury produced	
		Flasks	Pounds per ton of ore
1971	265,790	17,444	5.0
1972	82,580	[2]7,004	6.5
1973	26,257	[2]2,101	6.1
1974	28,858	[2]1,680	4.4
1975	76,772	6,905	6.8

[1] Excludes mercury produced from old surface ores, dumps, placers, and as a byproduct.
[2] Includes mercury contained in concentrate for export.

Table 4.—Production of secondary mercury in the United States

(Flasks)

Year	Industrial production	GSA releases	Total
1971	10,899	5,767	16,666
1972	12,139	512	12,651
1973	7,746	2,583	10,329
1974	5,940	2,353	8,293
1975	7,538	500	8,038

CONSUMPTION AND USES

Consumption, reversing the upward trend of recent years, declined 15% to 50,838 flasks. Much of the decline was attributed to depressed economic conditions in the first half of the year. As economic conditions began to improve in the second half of the year, consumption of mercury also began to rise and by yearend, nearly every use reported increased demand.

Of the two largest applications, use in electrical apparatus declined 14% to 16,971 flasks and use in the preparation of chlorine and caustic soda declined 10% to 15,222 flasks. In the aggregate, these two uses accounted for 63% of total consumption. Use in industrial and control instruments declined 26% to 4,598 flasks, and use in dental preparations declined 23% to 2,340 flasks. Use as catalysts fell from 1,298 flasks in 1974 to 838 flasks in 1975. Similar losses occurred in agriculture use, down from 980 flasks to 600 flasks, and in pharmaceutical use, down from 597 flasks to 445 flasks. The only application reporting an increase over 1974 was mildew-proofing paint, which rose slightly to 6,928 flasks.

Of the 50,838 flasks consumed in 1975, 75% consisted of primary mercury, 21% of redistilled mercury, and 4% of secondary mercury. Primary mercury was used through the whole range of applications, whereas redistilled mercury was used principally in dental preparations, electrical apparatus, and industrial and control instruments, reflecting the high purity required in the three applications. The bulk of the secondary mercury was used in dental preparations, electrical apparatus, chlorine and caustic soda production, and industrial and control instruments.

Table 5.—Mercury consumed in the United States, by use

(Flasks)

Use	1971	1972	1973	1974	1975
Agriculture [1]	1,477	1,836	1,830	980	600
Amalgamation	--	--	--	--	7
Catalysts	1,012	800	673	1,298	838
Dental preparations	2,361	2,983	2,679	3,024	2,340
Electrical apparatus	16,885	15,553	18,000	19,678	16,971
Electrolytic preparation of chlorine and caustic soda	12,154	11,519	13,070	16,897	15,222
General laboratory use	1,798	594	658	476	335
Industrial and control instruments	4,871	6,541	7,155	6,202	4,598
Paint:					
Antifouling	414	32	32	6	--
Mildew-proofing	8,191	8,190	7,571	6,807	6,928
Paper and pulp manufacture	2	1	--	--	--
Pharmaceuticals	682	578	606	597	445
Other [2]	2,407	4,258	1,913	2,452	1,750
Total known uses	52,254	52,885	54,187	58,417	50,034
Total unknown uses	3	22	96	1,062	804
Grand total	52,257	52,907	54,283	59,479	50,838

[1] Includes fungicides and bactericides for industrial purposes.
[2] Includes mercury used for installation and expansion of chlorine and caustic soda plants.

Table 6.—Mercury consumed in the United States in 1975

(Flasks)

	Primary	Redistilled	Secondary	Total
Agriculture [1]	600	--	--	600
Catalysts	524	150	164	838
Dental preparations	141	1,977	222	2,340
Electrical apparatus	11,765	4,912	294	16,971
Electrolytic preparation of chlorine and caustic soda	14,870	--	352	15,222
General laboratory use	160	159	16	335
Industrial and control instruments	1,363	2,666	569	4,598
Paint: Mildew-proofing	6,928	--	--	6,928
Pharmaceuticals	14	431	--	445
Other [2]	1,524	226	7	1,757
Total known uses	37,889	10,521	1,624	50,034
Total unknown uses	12	402	390	804
Grand total	37,901	10,923	2,014	50,838

[1] Includes fungicides and bactericides for industrial purposes.
[2] Includes amalgamation.

Table 7.—Stocks of mercury, December 31

(Flasks)

Year	Producer	Consumer and dealer	Total
1971	5,373	11,489	16,862
1972	4,171	11,537	15,708
1973	3,927	14,019	17,946
1974	4,100	15,777	19,877
1975	4,858	20,691	25,549

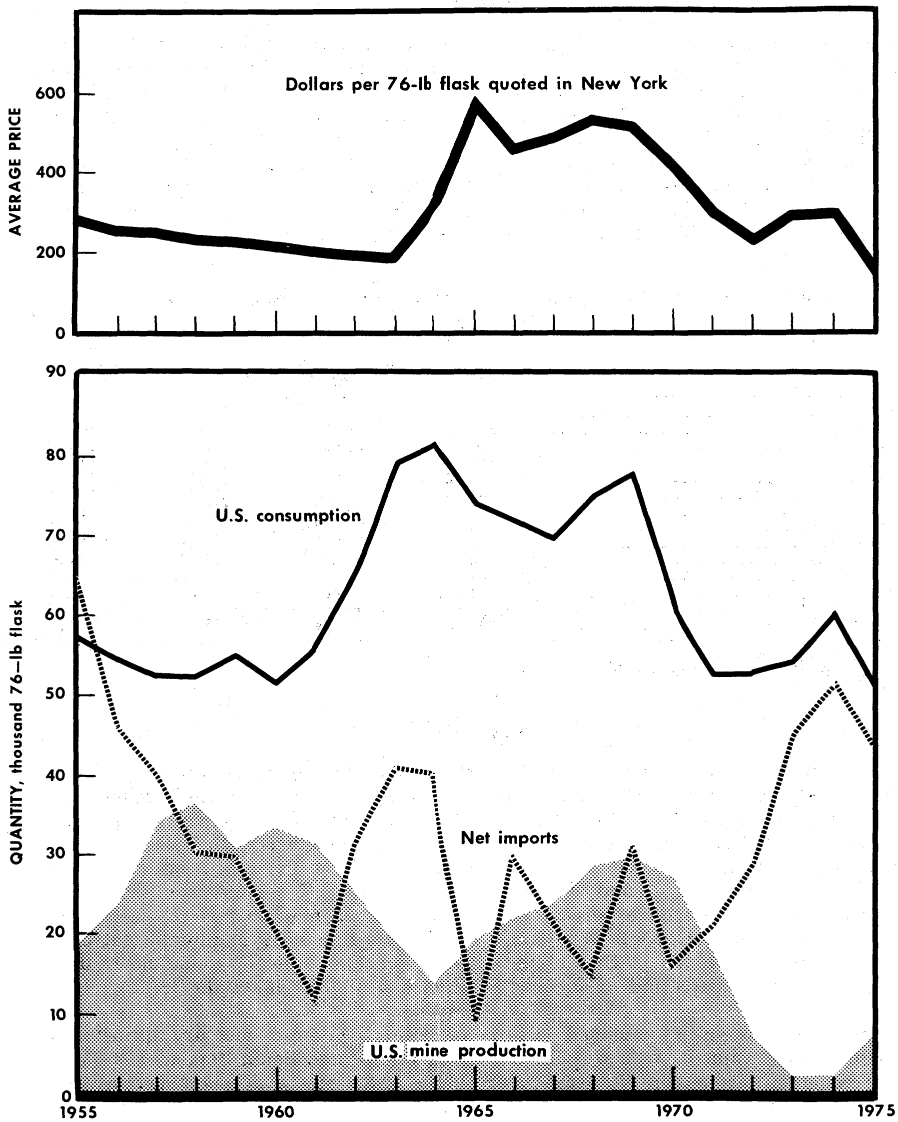

Figure 1.—Trends in production, consumption, and price of mercury.

PRICES

Prices of primary mercury dropped steadily during 1975, and by yearend were nearly half those of the beginning of the year. On December 29, 1975, the New York price of mercury was $123 per flask contrasted to $225 per flask on January 2, 1975. The average flask price for the year amounted to $158.12 compared with $281.69 in 1974. The London price suffered similarly, falling from $165 per flask on January 6, 1975, to $77 per flask at yearend. National and international price declines were attributed to decline in demand, world oversupply, the opening in the United States of the large McDermitt mine, and the possibility of mercury disposal from stockpiles held by the U.S. Government.

Table 8.—Average monthly price of mercury at New York and London
(Per flask)

Month	1974		1975	
	New York [1]	London [2]	New York [1]	London [2]
January	$275.45	$266.72	$221.36	$188.75
February	284.22	269.50	225.11	194.69
March	288.27	270.25	195.43	170.00
April	282.32	267.95	162.73	141.75
May	294.32	274.44	159.57	137.06
June	335.00	315.63	152.38	127.50
July	317.50	304.45	138.73	114.69
August	289.09	274.73	138.95	114.67
September	279.15	272.19	135.48	111.69
October	265.36	259.56	129.59	103.07
November	254.94	245.50	120.82	84.08
December	214.52	194.39	117.23	78.28
Average	281.69	267.94	158.12	130.11

[1] Metals Week, New York.
[2] Metal Bulletin, London; reported in terms of U.S. dollars.

FOREIGN TRADE

Exports of mercury totaled 339 flasks valued at $152,000 compared with 466 flasks valued at $270,000 in 1974. Reexports totaled 155 flasks valued at $68,000. Shipments to Canada, Colombia, Venezuela, Brazil, Saudi Arabia, and Taiwan accounted for 80% of the exports. The remainder went mainly to South American and African nations. Three-quarters of the reexports went to Canada and one-quarter to Taiwan.

Imports for consumption declined 16% to 43,865 flasks valued at $7.6 million. The average unit value for the year was $173.24 per flask compared with $267.31 per flask in 1974.

Imports from nations in the Western Hemisphere, Canada, Mexico, Peru, and the Philippines, in the aggregate, fell 44% to 16,129 flasks valued at $2.5 million. The low U.S. price combined with the opening of the McDermitt mine served to reduce imports from Canada by 24%, and to eliminate imports from the Philippines.

Imports from other principal suppliers, Spain, Italy, Algeria, Turkey, and Yugoslavia, in the aggregate gained 15% to 25,605 flasks valued at $4.8 million. A more than eight-fold increase in imports from Italy combined with a 2% increase in imports from Yugoslavia offset declines ranging from 11% to 84% from the others. Other nations tend to export mercury to the United States on an intermittent basis and, in general, annual fluctuations in their shipments do not affect the level of U.S. imports.

Imports of scrap mercury, principally from France and Spain, totaled 779 flasks.

The U.S. rate of duty on mercury imports during 1975 was $9.50 per flask.

Table 9.—U.S. exports and reexports of mercury

Year	Exports		Reexports	
	Flasks	Value (thousands)	Flasks	Value (thousands)
1973	342	$170	--	--
1974	466	270	--	--
1975	339	152	155	$68

Table 10.—U.S. imports for consumption[1] of mercury, by country

Country	1973		1974		1975	
	Flasks	Value (thousands)	Flasks	Value (thousands)	Flasks	Value (thousands)
Algeria	11,876	$3,135	10,449	$2,843	9,296	$1,561
Belgium-Luxembourg	5	6	--	--	--	--
Canada	17,440	4,748	16,972	4,592	12,891	1,840
China, People's Republic of	99	29	--	--	200	37
Denmark	50	13	--	--	--	--
Finland	--	--	15	5	35	6
France	--	--	--	--	400	81
Germany, West	100	27	500	142	400	49
Italy	1,005	260	845	212	7,340	1,595
Japan	--	--	45	13	--	--
Mexico	2,775	710	10,597	2,830	2,213	442
Netherlands	300	84	--	--	601	68
Peru	626	153	1,276	333	1,025	207
Philippines	50	15	100	26	--	--
Spain	7,286	1,834	6,293	1,624	4,575	968
Sweden	7	18	--	--	5	8
Switzerland	6	10	4	7	--	--
Taiwan	40	12	--	--	--	--
Turkey	700	174	353	96	58	14
United Kingdom	13	5	486	67	--	--
U.S.S.R	--	--	--	--	490	101
Yugoslavia	3,648	923	4,245	1,158	4,336	627
Total	46,026	12,151	52,180	13,948	43,865	7,599

[1] General imports in 1973 were 46,076 flasks ($12,164,010), Yugoslavia 3,698 flasks ($935,973). In 1974, 52,102 flasks ($13,858,283), Italy 705 flasks ($178,675), Yugoslavia 4,307 flasks ($1,174,480). In 1975, 44,472 flasks ($7,223,497), Italy 7,525 flasks ($1,151,729) the U.S.S.R. 600 flasks ($122,533), Yugoslavia 4,498 flasks ($645,967), and the People's Republic of China 350 flasks ($64,885).

WORLD REVIEW

World production of mercury declined to 251,226 flasks in 1975. Throughout most of the year, declining demand coupled with falling prices tended to keep mine output at or below levels of the preceding year. Large inventories throughout the world served to keep prices down when demand began to improve toward yearend.

Table 11.—Mercury: World production by country
(Flasks)

Country	1973	1974	1975 [p]
Algeria	13,300	[e] 13,300	[e] 13,300
Australia	16	2	[e] 1
Canada	12,500	14,000	[e] 14,000
Chile	798	921	97
China, People's Republic of [e]	26,000	26,000	26,000
Colombia	144	[r] [e] 79	[e] 100
Czechoslovakia	[r] 6,498	5,541	[e] 6,000
Finland	196	183	309
Germany, West	4,700	6,817	[e] 7,000
Ireland	1,345	775	[e] 800
Italy	[r] 33,504	25,991	[e] 30,400
Japan	3,742	1,409	--
Mexico	[1] [r] 21,646	25,933	14,184
Peru	3,581	3,253	[e] 3,500
Philippines	[r] 2,169	812	232
Spain	[r] 62,069	55,045	47,051
Tunisia	112	[e] 145	[e] 145
Turkey	[r] 7,861	8,731	[e] 8,800
U.S.S.R. [e]	52,000	54,000	55,000
United States	2,227	2,189	7,366
Yugoslavia	15,606	15,838	16,941
Total	[r] 270,014	260,964	251,226

[e] Estimate. [p] Preliminary. [r] Revised.
[1] Exports.

Japan.—Nomura Kosan Co. Ltd. continued to be the only Japanese supplier of mercury as all mercury mines remained closed in 1975. The company reclaims a large volume of mercury from used electrical appliances. Chlorine and caustic soda producers continued large capital outlays to convert production facilities from mercury cells to diaphragm cells. Conversion was expected to be completed in 1978.

Spain.—Recent exploration at the Almaden mine has reportedly located much larger reserves than previously indicated. Exploratory drilling at the site of an ancient abandoned mercury mine north of the Almaden discovered an extremely rich deposit of cinnabar at a comparative shallow depth. The extent of this new deposit had not been ascertained at yearend.

U.S.S.R.—Development of rich new deposits discovered in recent years has made the U.S.S.R. self-sufficient in mercury and permitted exportation of the metal. Exports by the U.S.S.R. in 1975 are believed to have been greater than 25,000 flasks.

Table 12.—Mercury: Exports from Italy, Spain, and Yugoslavia, by country

(Flasks)

Destinations	Italy			Spain			Yugoslavia		
	1973	1974	1975	1973	1974	1975	1973	1974	1975 [1]
Australia	--	NA	NA	406	232	609	--	--	
Belgium-Luxembourg	r 661	NA	5,509	145	87	1,073	100	--	
Canada	--	--	NA	174	783	174	--	--	
Colombia	r 1	NA	NA	--	435	--	1,338	--	
Egypt	--	NA	NA	--	145	--	--	--	
Finland	--	NA	NA	145	--	--	--	--	
France	r 2,824	1,752	3,632	3,249	1,566	609	121	--	
Germany, East	r 1,801	4,302	12,128	2,843	--	--	--	--	
Germany, West	r 3,093	1,651	5,926	5,047	6,295	1,682	570	--	
Greece	r 2	NA	NA	9	(2)	--	--	--	
Hungary	r 200	NA	NA	--	--	174	600	200	
India	r 4,654	NA	3,507	3,916	9,254	2,379	--	--	NA
Iraq	--	NA	NA	--	609	--	--	--	
Japan	r 1,042	NA	NA	4,699	696	435	--	--	
Netherlands	r 891	400	3,052	377	667	319	--	--	
Poland	r 500	NA	NA	377	2,002	377	--	--	
Portugal	r 1	NA	NA	290	203	87	--	--	
Romania	--	NA	NA	5,889	--	2,031	--	--	
South Africa, Republic of	r 575	NA	NA	435	667	435	--	--	
Sweden	----	NA	NA	2,060	1,595	--	--	--	
Switzerland	1,015	NA	NA	928	667	87	200	50	
Taiwan	--	NA	NA	232	986	--	--	--	
United Kingdom	r 400	4,798	4,714	7,165	5,365	3,713	--	--	
United States	r 856	1,671	6,640	7,165	6,266	4,264	9,917	8,152	4,201
Venezuela	r 1	NA	NA	1,595	--	--	--	--	NA
Other countries and undistributed	r 222	2,613	4,357	1,327	525	378	705	1,109	NA
Total	r 18,739	17,187	49,465	48,473	39,045	18,826	13,551	r 9,511	4,201

NA Not available.
[1] Data for 6 months only.
[2] Less than ½ unit.

TECHNOLOGY

Mercury ore was roasted using a fluidized-bed technique that allowed maximum extraction from particles with a wide range of sizes.[5] Good fuel economy was realized. Mercury ore was leached with aqueous sodium hypochlorite to produce mercury chloride, which in turn was stripped from the aqueous solution using a mixture of trioctylamine and kerosine, followed by a highly alkaline aqueous solution.[6]

Scanning electron microscopy was used to study mercury ore from the Almaden mine in Spain in an attempt to determine the origin of the ore deposit.[7] The study indicated that mineralization of the main

[5] Mikhailov, V. K. (assigned to Gosudarstverny Nauchno-Issledovatelsky Institute Tevetnykh Metalov "Gintsvetmet"). Fluid Dye Bed Roasting of Ores and Concentrates. Can. Pat. 977,553, Nov. 11, 1975.

[6] Chapman, T. W., and R. Caban (assigned to Wisconsin Alumni Research Foundation). Extraction of Mercuric Chloride from Dilute Solution and Recovery. U.S. Pat. 3,899, 570, Aug. 12, 1975.

[7] Caluo, F. A., and J. M. Guilemany. Structure and Origin of Mercury Ore From Almaden, Spain. Inst. Min. Met., Trans., sec. B., Bull. 828, v. 84, November 1975, pp. B146–B149.

ore body occurred with molten cinnabar and mineralization on the edge of the deposit occurred via a vapor-phase impregnation.

Determination of mercury using a spectrophotometer with 6-phenyl-2,3-dihydro-*as*-triazine-3-thione was reported.[8] A number of investigations on various kinds of mercury were conducted to develop analytical techniques useful in environmental pollution studies.[9]

Mercury was used successfully as a probe for capacitance-voltage measurements of certain types of silicon and other semiconductors.[10] The determination of mercury by the cold vapor atomic absorption method was investigated to ascertain the reason for the sometimes unreliability of the method.[11]

A multistage air sampler for mercury was developed that successfully detected mercury down to 0.3 nanogram with a precision of ±5%.[12] Stringent wastewater standards have led to the use of a variety of techniques for the removal of mercury from wastewater.[13]

Cold vapor atomic absorption used with two methods of decomposition was investigated for reliability in determining mercury in petroleum and petroleum products.[14] Both methods were successful, but considerable experience with the decomposition method was necessary to achieve reliable results. The cold vapor atomic absorption technique for determination of mercury was improved.[15]

Vicinal diothiol chemical components (VDT) were incorporated in alkaline cellulose to produce a very effective mercury adsorbent.[16] In one example, VDT cellulose reduced a mercury concentration of 1 part per million to less than 5 parts per billion.

[8] Maghssoudi, R. H., and F. A. Shamsa. Spectrophotometric Determination of Mercury (II) With 6-phenyl-2,3-dihydro-*as*-triazine-3-thione. Anal. Chem., v. 47, March 1975, pp. 550–552.

[9] Baltisberger, R. J., and C. L. Knudson. Investigation of Isothiocyanatopentaaquochromium (III) as a Reagent for the Separation and Identification of Nanogram Quantities of Mercury (I), Mercury (II), and Methylmercury (II). Anal. Chem., v. 47, July 1975, pp. 1402–1406.

Rabenstein D. L., C. A. Evans, M. C. Tourangeau, and M. T. Fairhurst. Methylmercury Species and Equilibrium Aqueous Solution. Anal. Chem., v. 47, February 1975, pp. 338–341.

[10] Severin, P. J., and H. Bulle. Four-Point Probe Measurements on N-Type Silicon With Mercury Probes. J. Electrochem. Soc., v. 122, No. 1, January 1975, pp. 133–137.

———. Spreading Resistance Measurements on N-Type Silicon Using Mercury Probes. J. Electrochem. Soc., v. 122, January 1975, pp. 137–142.

[11] Koirtyohann, S. R., and M. Khalil. Variables in the Determination of Mercury by Cold Vapor Atomic Absorption. Anal. Chem., v. 48, January 1976, pp. 136–139.

[12] Trujillo, P. E., and E. E. Campbell. Development of a Multistage Air Sampler for Mercury. Anal. Chem., v. 47, August 1975, pp. 1629–1634.

[13] Iammartino, N. R. Mercury Cleanup Routes II. Chem. Eng., v. 82, No. 3, 1975, pp. 36–37.

Ricci, L. J. Heavy-Metals Recovery Promises To Pare Water-Cleanup Bills. Chem. Eng., v. 82, No. 27, Dec. 22, 1975, pp. 29–31.

Rosenzweig, M. K. Mercury Cleanup Routes I. Chem. Eng., v. 82, January 1975, pp. 60–61.

[14] Knauer, H. E., and G. E. Millman. Analysis of Petroleum for Trace Metals—Determination of Mercury in Petroleum and Petroleum Products. Anal. Chem., v. 47, July 1975, pp. 1263–1268.

[15] Hawley, J. E., and J. D. Ingle, Jr. Improvements in Cold Vapor Atomic Absorption Determination of Mercury. Anal. Chem., v. 47, April 1975, pp. 719–723.

[16] Marchant, W. N. (assigned to the Secretary of the Interior). Removal of Mercury From Solutions. U.S. Pat. 3,864,327, June 12, 1975.

Mica

By Stanley K. Haines [1]

Domestic production of mica [2] consisted of a small quantity of sheet mica from North Carolina and a large quantity of scrap and flake mica. Production of scrap and flake mica decreased 2%, and output of ground mica decreased 3%.

Consumption of block and film mica, predominantly imported material, decreased significantly in both quantity and value in 1975. Mica splittings (muscovite and phlogopite) also suffered a large decline in consumption in 1975. Exports of all classes of mica decreased in quantity but increased in value. Imports of uncut sheet and punch and scrap increased in quantity, while manufactured mica declined in quantity and value.

Legislation and Government Programs.—The Defense Materials Inventory stockpile objectives for all categories of sheet mica remained the same. Shipments of excess mica by the General Services Administration (GSA) amounted to 3,445,000 pounds.

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Unless stipulated in the text, mica refers to the muscovite mica variety.

Table 1.—Salient mica statistics

	1971	1972	1973	1974	1975
United States:					
Sold or used by producers:					
Sheet mica .... thousand pounds ..	17	14	30	20	5
Value .... thousands ..	$7	$7	$15	$10	$3
Scrap and flake mica thousand short tons ..	127	148	153	137	135
Value .... thousands ..	$2,917	$4,353	$6,082	$5,475	$5,219
Ground mica .... thousand short tons ..	119	130	137	117	113
Value .... thousands ..	$8,280	$8,844	$9,464	$10,171	$9,312
Consumption, block and film thousand pounds ..	1,301	1,207	1,265	974	623
Value .... thousands ..	$2,259	$2,026	$2,106	$2,015	$1,608
Consumption, splittings . thousand pounds ..	4,177	4,324	5,178	6,186	4,746
Value .... thousands ..	$1,818	$1,771	$1,715	$2,801	$2,634
Exports .... thousand short tons ..	8	7	8	9	6
Imports for consumption .... do	7	5	6	7	8
World production .... thousand pounds ..	375,554	510,135	r 542,722	r 515,410	515,616

r Revised.

Table 2.—Defense Materials Inventory for sheet mica as of December 31, 1975
(Pounds)

Category	Stockpile objective	Total inventory	Uncommitted excess	Balance of disposal authorization	Sold in 1975
Muscovite block, Stained or better	1,600,000	5,108,133	3,508,133	--	1,508,255
Muscovite film, 1st and 2d qualities	413,000	1,350,420	937,420	82,641	24,896
Muscovite splittings	2,200,000	23,728,419	21,528,419	4,668,544	4,825,213
Phlogopite block	51,000	146,885	95,885	99,885	1,200
Phlogopite splittings	200,000	3,405,928	3,205,928	2,455,928	79,200

DOMESTIC PRODUCTION

Sheet Mica.—A small quantity of sheet mica was produced and sold locally in North Carolina. The sheet mica was generally of low quality and grade, and was not mined as the primary product of the producing company.

Scrap and Flake Mica.—Production of scrap and flake mica declined 2% from that of 1974 to 134,885 short tons in 1975. The value declined 5% from $5,474,636 in 1974 to $5,219,461 in 1975. North Carolina remained the leading mica-producing State, with 56% of total production. The remaining 44% of scrap and flake output came from Alabama, Arizona, Connecticut, Georgia, New Mexico, Pennsylvania, South Carolina, and South Dakota. Scrap and flake mica was produced from the beneficiation of pegmatite ores, clay deposits, and weathered pegmatite and schist areas.

Leading producers of scrap and flake mica were Harris Mining Co., Spruce Pine, N.C.; Western Mica Co., Div. of United States Gypsum Co., Chicago, Ill.; Mineral Industrial Commodities of America, Inc., Santa Fe, N.M.; Feldspar Corp., Spruce Pine, N.C.; and Kings Mountain Mica Co., Inc., Kings Mountain, N.C.

Table 3.—Mica sold or used by producers in the United States

Year and State	Sheet mica						Scrap and flake mica [1]	
	Uncut punch and circle mica		Uncut mica larger than punch and circle		Total sheet mica			
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value
1971	17,005	$6,652	--	--	17,005	$6,652	127,084	$2,916,879
1972	14,280	7,140	--	--	14,280	7,140	147,883	4,353,313
1973	--	--	30,000	$15,000	30,000	15,000	153,327	6,081,893
1974	--	--	r 20,000	r 10,000	r 20,000	r 10,000	136,966	5,474,636
1975:								
Arizona	--	--	--	--	--	--	2,034	64,918
North Carolina	--	--	5,000	2,500	5,000	2,500	75,297	3,264,703
South Carolina	--	--	--	--	--	--	6,726	317,588
Other States [2]	--	--	--	--	--	--	50,828	1,572,252
Total	--	--	5,000	2,500	5,000	2,500	134,885	5,219,461

r Revised.
[1] Includes finely divided mica recovered from mica and sericite schist, and mica that is a byproduct of feldspar and kaolin beneficiation.
[2] Includes Alabama, Connecticut, Georgia, New Mexico, Pennsylvania, and South Dakota.

Ground Mica.—Sales of ground mica decreased 3% in quantity and 8% in value. Dry-ground mica production increased slightly in both quantity and value, while wet-ground mica decreased 29% in quantity and 26% in value. Sixteen companies, operating a total of eighteen plants, processed scrap and flake mica. Fourteen of these plants produced dry-ground mica, three produced wet-ground mica, and one produced wet- and dry-ground mica.

Leading producers of ground mica were Harris Mining Co., Spruce Pine, N.C.; United States Gypsum Co., Chicago, Ill.; Deneen Mica Co., Inc., Micaville, N.C.; Mineral Industrial Commodities of America, Inc., Santa Fe, N.M.; and Thompson-Weinman & Co., Cartersville, Ga.

Table 4.—Ground mica sold or used by producers in the United States[1] by method of grinding

Year	Dry-ground		Wet-ground		Total	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1971	103,308	$5,463	16,176	$2,817	119,484	$8,280
1972	104,625	5,500	25,649	3,343	130,274	[2]8,844
1973	120,762	6,469	15,739	2,995	136,501	9,464
1974	101,455	6,335	15,908	3,836	117,363	10,171
1975	102,209	6,483	11,244	2,829	113,453	9,312

[1] Domestic and some imported scrap.
[2] Data do not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Sheet Mica.—Consumption of block and film mica suffered a large drop in 1975. Fabrication of block and film mica (muscovite and phlogopite) declined 36% to 622,848 pounds. Of the total consumption, 94% was muscovite block, 5% was phlogopite block (magnesium mica), and 1% was muscovite film.

Vacuum tubes required 64% of the total muscovite block fabricated. The remaining fabricated block was used in gage glass and diaphragms (2%) and capacitors and other uses (34%). Lower than Stained muscovite block mica was in greatest demand and accounted for 58% of consumption; Stained accounted for 40%; and Good Stained or better, 2%.

Muscovite film consumption continued to decline, dropping from 8,671 pounds in 1974 to 7,243 pounds. The film was consumed primarily in the fabrication of capacitors.

Muscovite block and film was consumed by 13 companies in 7 States. North Carolina, New Jeresy, and New York had three consuming plants each, while Massachusetts, Ohio, Pennsylvania, and Virginia had one plant each.

Phlogopite block consumption dropped from 62,513 pounds in 1974 to 28,512 pounds. Phlogopite was consumed by six companies in five States. Virginia and New Jersey were the primary fabricating States.

In 1975, Victory Mica Manufacturing Co. and Ford Radio and Mica Corp. ceased sheet-mica-fabricating operations and sold their stocks of mica. Other companies in the industry may be adversely affected by the closing of the RCA electronic tube plant in New Jersey.

Consumption of mica splittings (musovite and phlogopite) decreased from 6,186,000 pounds in 1974 to 4,746,000 pounds. India and the Malagasy Republic supplied the bulk of the splittings consumed domestically. Splittings were fabricated into various built-up mica products by 10 companies with 11 plants in 8 States. Five plants located in Ohio, New York, and New Hampshire consumed 3.9 million pounds of splittings, or 82% of total consumption.

The declines in sheet-mica consumption were due to a combination of problems. First was the general economic recession, which decreased demand for consumer appliances that use a good deal of the mica fabricated in the United States. Second was the continual increase in prices for the raw material. As mica becomes more and more expensive, consumers are finding cheaper substitutes, both mica based (mica paper) and nonmica based (ceramics).

Built-up Mica.—This mica-based substitute was produced in various forms, primarily for use as electrical insulating material. Production of all major built-up mica products declined in quantity and value. The forms of built-up mica in greatest demand were segment plate 32%, molding plate 26%, and tape 19%.

Reconstituted Mica.—Five companies manufactured this mica-based material from good-quality delaminated scrap mica. The manufacturing companies were General Electric Co., Schenectady, N.Y.; U.S. Samica Corp., Rutland, Vt.; Acim Paper Corp., Hempstead, N.Y.; Essex Group, United Technologies Corp., New Market, N.H.; and Corona Films Inc., West Townsend, Mass.

Essex Magnet Wire & Insulation Div. in New Market, N.H., opened its new

30,000-square-foot building; the company has developed new manufacturing and control methods to produce mica paper. The products include a 100% mica product, which is further processed by adding various binders, heat, and pressure to produce the desired mica-paper insulating products. The Essex facility is the only integrated processing plant in the United States whereby the raw mica is converted from scrap into high-quality finished products in one continuous process. Current capacity of the facility is in excess of 1 million pounds per year.

The newly formed Vermont corporation, U.S. Samica Corp., purchased the operating equipment for mica-paper production from 3M Co. and will continue to produce and market mica paper. The firm has developed a new mica paper called Micanite II, which is between actual built-up mica from splittings and traditional mica paper. The product is a heavy paper usable for a variety of electrical insulating applications.

Ground Mica.—The ground-mica industry suffered a 3% drop in sales below the already depressed level of 1974. Sales of ground mica for use in roofing materials, paint, and joint cement declined 13%, 34%, and 36%, respectively. Use of ground mica in wallpaper increased over 1974 levels.

Table 5.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica, by quality and end-product use in the United States in 1975

(Pounds)

Variety, form, quality	Electronic uses: Capacitors	Electronic uses: Tubes	Electronic uses: Other	Electronic uses: Total	Nonelectronic uses: Gage glass and diaphragms	Nonelectronic uses: Other	Nonelectronic uses: Total	Grand total
Muscovite:								
Block:								
Good Stained or better	720	695	2,808	4,223	2,104	5,222	7,326	11,549
Stained	142	154,552	31,075	185,769	2,819	44,586	47,405	233,174
Lower than Stained[1]	--	218,695	15,220	233,915	10,450	98,005	108,455	342,370
Total	862	373,942	49,103	423,907	15,373	147,813	163,186	587,093
Film:								
1st quality	2,075	1,500	22	3,597	--	--	--	3,597
2d quality	2,586	--	60	2,646	--	--	--	2,646
Other quality	1,000	--	--	1,000	--	--	--	1,000
Total	5,661	1,500	82	7,243	--	--	--	7,243
Block and film:								
Good Stained or better[2]	2,795	2,195	2,830	7,820	2,104	5,222	7,326	15,146
Stained[3]	2,728	154,552	31,135	188,415	2,819	44,586	47,405	235,820
Lower than Stained	1,000	218,695	15,220	234,915	10,450	98,005	108,455	343,370
Total	6,523	375,442	49,185	431,150	15,373	147,813	163,186	594,336
Phlogopite: Block (all qualities)	--	--	150	150	--	28,362	28,362	28,512

[1] Includes punch mica.
[2] Includes 1st and 2d quality film.
[3] Includes other-quality film.

Table 6.—Fabrication of muscovite ruby and nonruby block and film mica by quality and grade in the United States, in 1975
(Pounds)

Form, variety, quality	No. 4 and larger	No. 5	No. 5½	No. 6	Other [1]	Total
Block:						
Ruby:						
Good Stained or better	4,990	1,821	301	920	--	8,032
Stained	11,243	61,119	31,850	77,029	3,299	184,540
Lower than Stained	9,406	87,044	30,823	117,265	34,848	279,386
Total	25,639	149,984	62,974	195,214	38,147	471,958
Nonruby:						
Good Stained or better	2,012	850	--	655	--	3,517
Stained	40,107	4,145	1,504	2,878	--	48,634
Lower than Stained	4,520	200	--	2,550	55,714	62,984
Total	46,639	5,195	1,504	6,083	55,714	115,135
Film:						
Ruby:						
1st quality	950	772	400	750	--	2,872
2d quality	195	726	900	100	--	1,921
Other quality	--	--	--	--	1,000	1,000
Total	1,145	1,498	1,300	850	1,000	5,793
Nonruby:						
1st quality	--	--	400	325	--	725
2d quality	--	--	725	--	--	725
Other quality	--	--	--	--	--	--
Total	--	--	1,125	325	--	1,450

[1] Figures for block mica include all mica smaller than No. 6 grade, and punch mica.

Table 7.—Consumption and stocks of mica splittings in the United States, by source
(Thousand pounds and thousand dollars)

	India		Malagasy		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
Consumption:						
1971	4,084	1,750	93	68	4,177	1,818
1972	4,245	1,658	79	113	4,324	1,771
1973	5,063	1,606	115	109	5,178	1,715
1974	6,026	2,673	160	128	6,186	2,801
1975	4,625	2,529	120	104	4,746	2,634
Stocks on Dec. 31:						
1971	1,317	NA	98	NA	1,415	NA
1972	1,723	NA	86	NA	1,809	NA
1973	1,246	NA	55	NA	1,301	NA
1974	3,170	NA	87	NA	3,257	NA
1975	3,465	NA	35	NA	3,500	NA

NA Not available.
[1] Data may not add to totals shown because of independent rounding.

Table 8.—Built-up mica [1] sold or used in the United States, by product
(Thousand pounds and thousand dollars)

Product	1974		1975	
	Quantity	Value	Quantity	Value
Molding plate	1,549	3,977	1,272	2,790
Segment plate	1,786	3,876	1,557	3,605
Heater plate	W	W	155	428
Flexible (cold)	843	1,976	705	1,724
Tape	1,442	4,503	930	3,467
Other	479	1,389	253	1,075
Total	6,099	[2] 15,720	4,872	13,089

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Consists of alternate layers of binder and irregularly arranged, partly overlapped splittings.
[2] Data do not add to total shown because of independent rounding.

Table 9.—Ground mica sold or used by producers in the United States, by use

Use	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Roofing	9,677	$445	8,458	$396
Wallpaper	W	W	18,123	1,637
Rubber	6,605	1,427	4,336	936
Paint	33,553	3,319	22,298	2,657
Joint cement	40,744	2,727	25,891	1,841
Other uses [1]	26,784	2,252	34,347	1,848
Total [2]	117,363	10,171	113,453	9,312

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes mica used for agricultural products, molded electric insulation, annealing, plastics, welding rods, well-drilling, textile and decorative coating, brick, and uses indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

STOCKS

At yearend there was 4.1 million pounds of sheet mica in fabricators' stocks. Of this total, 85.2% was splittings, 14.6% was block, and 0.2% was film. This information was obtained by a direct canvass of sheet-mica fabricators.

PRICES

The average values per pound of muscovite sheet in 1975, based on consumption data, follow: Block, $2.59; film, $3.90; and splittings, $0.55. The average value per pound of phlogopite sheet mica, also based on consumption data, follow: Phlogopite block, $2.14; and phlogopite splittings, $0.87.

The average value of scrap and flake mica produced during 1975 was $38.78 per ton, slightly lower than the 1974 value. Prices for wet- and dry-ground mica quoted in the Chemical Marketing Reporter essentially remained at 1974 levels.

Table 10.—Price of dry- or wet-ground mica in the United States in 1975 [1]

	Cents per pound
Dry-ground:	
Joint cement, 100 mesh	4–5
Plastic, 100 mesh	4–5
Roofing, 20 to 80 mesh	2-½–3-½
Wet-ground: [2]	
Paint or lacquer, 325 mesh	11–13
Rubber	11–13
Wall paper	12–18

[1] In bags at works, carlots, unless otherwise noted.
[2] Freight allowed east of the Mississippi River.
Source: Chemical Marketing Reporter. V. 208, No. 25, Dec. 22, 1975.

FOREIGN TRADE

Total mica exports decreased 32% in quantity but increased 9% in value. Over 55% of the sheet, scrap, flake, and ground mica exported was shipped to Canada, the United Kingdom, Venezuela, Saudi Arabia, and France. Reported export data did not provide information on the grade or type of mica exported, but it is assumed that the major portion of the material exported was ground mica.

Imports of waste and scrap mica increased 61% in quantity. Sheet mica imports increased 14% in quantity, but decreased 27% in value. Processed-mica imports decreased 23% in quantity and 40% in value.

Table 11.—U.S. exports and imports of mica
(Thousand pounds and thousand dollars)

Year	Exports: All classes		Imports for consumption: Uncut sheet and punch		Scrap		Manufactured	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1973	15,744	5,265	1,169	1,269	r 5,073	116	4,785	4,325
1974	17,897	6,515	r 793	947	6,634	193	r 6,554	4,928
1975	12,110	7,104	904	696	10,672	356	5,075	2,935

r Revised.

Table 12.—U.S. exports of mica and manufactures of mica in 1975, by country

Destination	Mica, including block, film and splittings, waste and scrap, and ground mica: Pounds	Value (thousands)	Manufactured: Pounds	Value (thousands)
Argentina	6,872	$7	11,281	$34
Australia	56,469	6	14,722	37
Bahrain	176,200	25	502	4
Belgium-Luxembourg	134,074	19	401	4
Brazil	--	--	84,616	293
Canada	3,404,408	393	391,521	1,511
Chile	44,000	3	1,852	8
Colombia	181,722	31	1,368	18
Costa Rica	19,800	2	--	--
Czechoslovakia	17,599	37	--	--
Denmark	--	--	38,381	121
Dominican Republic	88,000	11	16,766	28
Ecuador	35,637	5	--	--
Egypt	58,200	8	--	--
El Salvador	200,000	11	--	--
France	561,019	66	78,397	151
Germany, West	355,343	61	4,997	13
Ghana	23,200	3	--	--
Greece	15,600	3	--	--
Guatemala	549,939	85	--	--
Honduras	30,398	4	362	1
Hong Kong	18,440	23	1,254	4
Hungary	26,427	76	--	--
Indonesia	33,000	2	142	1
Iran	30,000	5	1,890	10
Israel	33,600	4	24	1
Italy	319,059	58	67,407	300
Jamaica	50,800	4	9,388	11
Japan	532,802	616	6,239	21
Korea, Republic of	88,096	15	--	--
Malaysia	49,894	190	--	--
Mexico	57,156	60	123,065	429
Netherlands	125,255	278	1,404	12
Niger	435,000	20	--	--
Norway	160,000	17	527	2
Panama	5,000	1	83,273	76
Peru	42,850	6	19,800	80
Philippines	53,800	10	3,024	21
Saudi Arabia	647,020	58	1,845	4
Singapore	402,880	49	72	1
South Africa, Republic of	2,245	3	22,477	51
Spain	39,160	19	51,005	190
Sweden	33,220	5	2,899	17
Taiwan	149,017	93	64	1
Tanzania	48,000	20	--	--
Thailand	22,000	1	--	--
Trinidad and Tobago	40,000	7	1,167	3
United Arab Emirates	65,000	5	702	6
United Kingdom	752,306	624	45,428	364
Venezuela	683,984	78	24,974	14
Yugoslavia	--	--	10,983	60
Other	72,862	27	8,082	48
Total	10,977,353	3,154	1,132,301	3,950

Table 13.—U.S. imports for consumption of mica, by kind and country

Year and country	Unmanufactured							
	Waste and scrap[1]		Block mica		Other			
					Muscovite		Other n.e.c.	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1973	5,072,912	$116	994,661	$1,050	47,315	$28	126,689	$191
1974	6,633,773	193	582,832	724	49,920	21	160,628	202
1975:								
Brazil	1,428,598	55	211,018	284	--	--	229,466	58
Canada	--	--	--	--	--	--	30,739	14
France	--	--	4,416	1	--	--	--	--
India	9,126,778	298	21,086	169	982	8	391,178	81
Malagasy Republic	--	--	8,600	26	--	--	4,169	15
South Africa, Republic of	6,534	(2)	--	--	--	--	175	8
Sri Lanka	110,215	3	--	--	--	--	--	--
Taiwan	--	--	2,126	20	--	--	--	--
Tanzania	--	--	380	4	--	--	--	--
United Kingdom	--	--	55	3	102	5	--	--
Total	10,672,125	356	247,681	507	1,084	13	655,727	176

Year and country	Manufactured							
	Splittings		Not cut or stamped not over 0.006 inch in thickness		Cut or stamped			
					Not over 0.006 inch in thickness		Over 0.006 inch in thickness	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1973	3,628,802	$881	15,714	$30	142,365	$2,411	133,738	$260
1974	4,970,618	1,318	75,739	37	122,934	2,056	151,603	265
1975:								
Belgium-Luxembourg	--	--	--	--	6	(2)	--	--
Brazil	--	--	61	4	--	--	--	--
Canada	1,078	5	--	--	--	--	2,701	16
France	700	11	--	--	--	--	--	--
Haiti	--	--	--	--	807	14	--	--
India	3,726,236	853	3,550	4	28,331	319	55,674	106
Japan	--	--	--	--	--	--	18	1
Korea, Republic of	--	--	--	--	19	2	--	--
Malagasy Republic	62,497	42	--	--	--	--	--	--
Mexico	--	--	--	--	--	--	28	(2)
Spain	--	--	140	(2)	--	--	--	--
Taiwan	--	--	--	--	287	10	500	1
United Kingdom	--	--	--	--	894	5	185	3
Total	3,790,511	911	3,751	8	30,344	350	59,096	127

Year and country	Manufactured—Continued					
	Mica plates and built-up mica		Ground or pulverized		Articles not especially provided for of mica	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
1973	614,455	$620	223,882	$14	25,630	$109
1974	906,110	951	223,686	16	102,832	285
1975:						
Belgium-Luxembourg	934,331	1,147	--	--	--	--
Canada	18,345	64	179,950	16	4,768	35
France	--	--	11,023	6	--	--
Germany, West	8,134	16	--	--	64	2
Hong Kong	--	--	--	--	11	(2)
India	11,317	23	11,023	(2)	9,478	196
Japan	--	--	--	--	47	4
Laos	4	1	--	--	--	--
Mexico	26	2	--	--	--	--
Netherlands	--	--	--	--	117	13
Switzerland	--	--	--	--	120	1
United Kingdom	1,481	2	--	--	705	11
Total	973,638	1,255	201,996	22	15,310	262

[1] In 1973–1975, there were no transactions of phlogopite.
[2] Less than ½ unit.

WORLD REVIEW

World production of all forms of mica increased less than 1% from 1974 to 1975. India was the world leader for production of sheet mica. Brazil, the Malagasy Republic, and Argentina were other major sheet-mica-producing countries. The United States continued as the major world producer of scrap and flake mica for grinding purposes.

Canada.—Construction began on a new processing plant to beneficiate the Suzorite phlogopite mica from a huge deposit in northeast Quebec. The decision to move ahead with a full-scale plant was the result of successful operation of a pilot plant for the past 2 years. First-year capacity of the new plant is expected to be 10,000 tons per year, with planned expansion to 30,000 tons per year in 3 years. The project is a joint venture of Le Société Mineralurgique Laviolette of Montreal and Marietta Resources International, Ltd., a subsidiary of Martin Marietta Corp.

India.—Production of mica in India was primarily from about 100 regularly operated mines, with some production coming from smaller intermittent producers. The Government of India proposed and recommended implementing a program whereby a foreign company ordering mica would be required to purchase 40% of the order from the Government's Mica Trading Co. (MITCO), and the remaining 60% from traditional suppliers.

Floor prices for sheet mica were increased for most categories. In December, there were floor-price revisions for some categories of mica that resulted in a lower floor-price increase than had been set earlier in the year. In particular, one-half-inch scrap was originally set to increase 100% in price, but the Government later lowered the increase to 75% over the floor prices in effect before July 1975.

Export Linkers, one of India's leading exporters of mica scrap has expanded its activities into the production of ground mica. The grinding plant will have a capacity of 3,000 tons per year, and will allow the company to supply mica in sizes ranging from 9.5 millimeters down to 20 micrometers.[3]

From April 1974 to February 1975, the U.S.S.R. imported over 36% of the total Indian sheet-mica exports. Czechoslovakia, Romania, Hungary, East Germany, Poland, and West Germany increased their imports of sheet mica from India.[4]

U.S.S.R.—The U.S.S.R. is planning an underground mine followed by a strip mine to work the Kovdorsk phlogopite deposits. The first stage of production involves an underground room-and-pillar mine. The rooms will then be caved. Following this, a strip mining operation will remove the vermiculite overburden and work down to the phlogopite rubble.[5]

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[3] Industrial Minerals. More Mica from Export Linkers. No. 99, December 1975, p. 10.

[4] Industrial Minerals. Companies and Minerals. No. 98, November 1975, p. 54

[5] Mining Magazine. Kola Penninsula Phlogopite Mines. V. 134, No. 5, May 1976, p. 485.

Table 14.—Mica: World production, by country

(Thousand pounds)

Country [1]	1973	1974	1975 [p]
Argentina:			
Sheet	959	939	948
Waste, scrap, etc.	5,523	6,109	6,393
Brazil [2]	[r] 3,832	5,474	[e] 5,500
Colombia [e]	90	90	90
France [e]	[r] 8,800	[r] 8,800	8,800
Guatemala	[e] 2,600	(3)	--
India:			
Exports:			
Block [4]	[r] 2,280	2,123	[e] 2,200
Splittings [5]	[r] 12,632	14,279	[e] 14,300
Scrap [6]	[r] 47,505	61,970	[e] 61,700
Domestic consumption, all classes [e]	21,160	23,810	22,000
Total [e]	[r] 83,577	102,182	100,200
Korea, Republic of (sericite)	13,938	5,952	[e] 6,600
Malagasy Republic (phlogopite):			
Block	276	333	218
Splittings	1,248	1,215	981
Scrap	439	340	--
Mexico	1,724	1,861	1,367
Mozambique (including scrap)	683	1,883	1,984
Nepal	18	9	9
Norway (including scrap) [2]	9,800	9,167	[e] 9,000
Portugal	(3)	(3)	--
South Africa, Republic of:			
Sheet	(7)	(7)	--
Scrap	13,248	5,944	5,536
Sri Lanka (scrap)	600	397	5,432
Sudan	[e] 550	551	[e] 550
Tanzania, sheet	71	20	13
U.S.S.R. (all grades) [e]	88,000	90,000	92,000
United States:			
Sheet	30	20	5
Scrap and flake	306,654	273,932	269,770
Yugoslavia	62	192	220
Grand total	[r] 542,722	515,410	515,616

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, the People's Republic of China, Romania, Southern Rhodesia, Territory of South-West Africa, and Sweden are known to produce mica, but available information is inadequate to make reliable estimates of output levels.

[2] Exports.

[3] Revised to zero.

[4] Includes micanite and other built-up mica.

[5] Includes condenser film, washer, disks.

[6] Includes sheet, strips, powder.

[7] Less than ½ unit.

TECHNOLOGY

A combination of Suzorite phlogopite mica and glass polyester was used for various general applications. Tests were performed whereby the form and content of the mica and glass were varied to find the optimal combination with acceptable performance. The Suzorite and glass composites were shown to have a higher modulus, equal or slightly lower strength, and lower cost per unit weight than equivalent glass laminates.[6]

In addition to various sprayed-up techniques the Martin-Marietta laboratory has developed methods for compounding and injection-molding low-cost, high-strength thermoplastics that incorporate Suzorite phlogopite as a reinforcing agent. Applications currently being tested include several automobile components where strength and performance requirements are high.

Mykroy Ceramics Div. of Synthane-Taylor Corp. has developed a lower cost glass-bonded mica. The natural-mica-filled material is used for electrical and electronic applications that require tolerance of high heat. The product, Mykroy 740, can withstand continuous operating temperatures of 399° C. The ceramic is machinable with standard tooling.[7]

Mica has been used in cosmetics for many years. An example of a recent use is in the Almay Color Rich Dry Shadow by Almay, Inc. The mica imparts a pearly, sparkling, look when applied. The mica is pure or coated with titanium dioxide. In this particular case, the mica is used as a nonallergenic ingredient.

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[6] Xanthos, M., G. C. Hawley, and J. Antonnaci. Suzorite Mica/Glass Polyester Laminates for Marine and General Purpose Applications. Proc. 31st Ann. Tech. Conf. Reinforced Plastics/Composites Institute, 1976, Sec. 22–B, pp. 1–9.

[7] Electronics. New Products. V. 48, No. 18, Sept. 4, 1975, pp. 190–192.

Molybdenum

By John T. Kummer [1]

Production of molybdenum, both domestic and worldwide, declined in 1975. The decline was primarily due to lower byproduct recovery at copper mines. The year was also marked by lower consumption of molybdenum, especially by the iron and steel industry, which accounts for about 80% of the consumption each year. Despite reduced demand, prices of concentrate and other molybdenum products increased during 1975. Reportedly, higher operating expenses and the expansion of mining and production facilities necessitated the price increases. As a result of the expansion of mining and production capacity, domestic supply should be sufficient to meet demand for molybdenum in the near future.

Legislation and Government Programs.—In recent years, the General Services Administration (GSA) has been authorized to dispose of all molybdenum materials in the national stockpile because domestic production capacity was considered adequate to supply national emergency needs. By the close of 1975, all materials had been sold. Sales in 1975 consisted of 1,798,125 pounds of molybdenum in molybdenum disulfide (MoS_2) and 291,048 pounds in ferromolybdenum. GSA reported an inventory of sold, but unshipped, materials containing 1,133,680 pounds of molybdenum in MoS_2, 280,082 pounds in ferromolybdenum, and 72,696 pounds in molybdic oxide at yearend 1975.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient molybdenum statistics
(Thousand pounds contained molybdenum and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Concentrate:					
Production	109,592	112,138	115,859	112,011	105,980
Shipments	97,882	102,197	135,097	118,163	105,170
Value	$164,917	$170,530	$217,721	$234,658	$259,328
Consumption	66,399	62,560	82,477	91,706	90,046
Imports for consumption	854	385	458	155	2,567
Stocks Dec. 31: Mine and plant	29,077	45,243	21,998	r 18,659	10,680
Primary products:					
Production	67,016	64,841	85,046	88,509	87,612
Shipments	66,654	75,538	108,687	114,799	89,789
Consumption	40,950	45,558	57,049	63,476	51,743
Stocks Dec. 31: Producers	31,048	28,898	22,387	16,078	22,863
World: Production	171,064	178,423	r 183,698	r 189,274	178,883

r Revised.

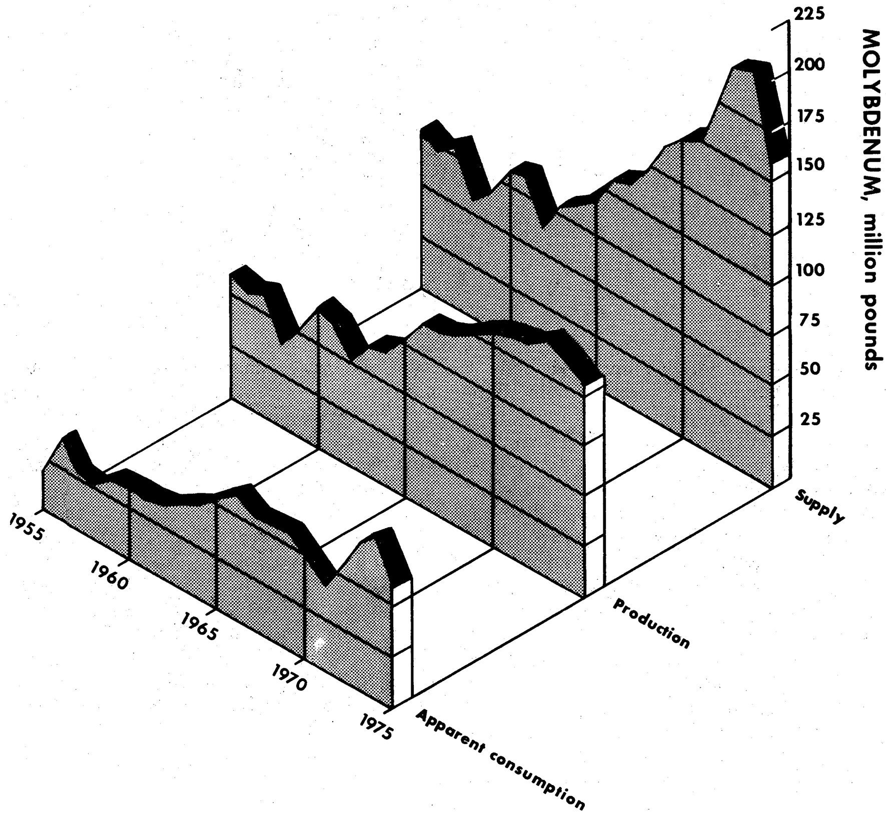

Figure 1.—Apparent consumption, production, and supply of molybdenum in the United States.

DOMESTIC PRODUCTION

Production of molybdenum in the United States decreased by 6 million pounds, 5.4% lower than in 1974 and 8.5% below the record production year of 1973. The declining production of molybdenum has been caused by lower output from byproduct plants at copper mining operations and, to a lesser extent, by the closure in late 1974 of the Urad mine (AMAX Inc.), a source of primary ore since 1967. A reduction in demand, associated with the general slowdown of industrial activity during 1975, also contributed to the drop in molybdenum production.

The two sources of primary molybdenite ore, the Climax mine of AMAX Inc., and the Questa mine of Molycorp, Inc., produced 70.7 million pounds of molybdenum, about 67% of the domestic output in 1975. Compared with that of 1974, production from primary ore deposits decreased 4.9%, chiefly due to the shutdown of operations at the Urad mine. The Climax mine was again the world's leading producer, supplying 33% of the estimated world production.

Production of byproduct molybdenum amounted to 35.3 million pounds, or 33%

of domestic output in 1975. Recovery of molybdenum as a byproduct declined 6.4% compared with that of 1974. A 2.2-million pound decrease in molybdenum output from 13 copper ore deposits accounted for most of the decline. The small amount of molybdenum obtained from tungsten and uranium operations also decreased in 1975. The two largest producers of byproduct molybdenum were the Sierrita mine of Duval Sierrita Corp. in Arizona and the Utah mine of Kennecott Copper Corp. Other significant sources of byproduct molybdenum were the Esperanza and Mineral Park properties of Duval Corp., the San Manuel mine of Magma Copper Co., and the Cyprus Pima property of Cyprus Mines Corp. All four are copper porphyry ore deposits located in Arizona.

Expansion of mining and processing facilities was continued during 1975 to insure future availability of molybdenum ore and primary products. Noteworthy among these activities has been the development of the Henderson mine and mill near Empire, Colo., by AMAX Inc. Mine and mill buildings had been erected and ore processing equipment was being installed by the end of 1975. The third, and final, mine shaft was completed in 1975. "Hole through" of the 9.6-mile-long ore haulage tunnel was accomplished in July 1975. The tunnel can accommodate a double tracked, fully automated railway system that will transport ore from the underground mine to the ore processing plant 14.4 miles away. Haulage capacity of 42,000 tons per day of molybdenite ore will be provided by 6 unit trains, each with 4 locomotives and 30 22-ton ore cars. Initial production, scheduled for the second half of 1976, was set at 2,000 tons per day with a goal of 30,000 tons per day by 1980.

AMAX Inc., has invested approximately $400 million since 1967 in developing the Henderson mine complex. Care has been taken to minimize environmental impact of land-clearing operations, road and building construction, and tailings disposal. The mill will use water recycled from the tailings pond to reduce contamination of the natural drainage system. By 1980, it is projected that output of the mine will reach 50 million pounds of molybdenum per year, an amount which will nearly double AMAX's current production.

In 1975 the molybdenum chemical plant at Fort Madison, Iowa, which has been under construction by AMAX Inc., since 1973, started converting technical-grade molybdic oxide to ammonium molybdates and high-purity molybdic oxide. A roaster complex and sulfuric acid plant was scheduled for completion in late 1976. During 1975, AMAX also expanded and modernized its production facility at Langeloth, Pa. Production capacity for molybdic oxide and lubrication-grade molybdenum disulfide was increased, and a sulfuric acid plant was under construction. With the addition of the Fort Madison plant, AMAX will have the capability to process in excess of 100 million pounds of molybdenum yearly by 1980.

Exploratory drilling during 1974 and the first half of 1975 by Molycorp revealed additional mineralization within its Questa mine holdings in northern New Mexico. Three separate mineralized zones have been encountered and, to finance further exploratory work, Molycorp entered into a partnership with Kennecott Copper Co. in July 1975. The agreement calls for Kennecott to contribute a minimum of $5 million prior to July 1977 for drilling and evaluation of the findings. Should this exploration add sufficient reserves to support a 20-million-pound annual mining and milling operation, the two companies would jointly develop the deposit. Production at the new mine would be shared by the two partners with both contributing equally to production and operating costs. It was hoped that the mining feasibility of these prospects could be determined by the end of 1976. The existing Questa mine was temporarily excluded from the partnership.

The Pinto Valley copper mining complex, developed by Cities Service Co., began continuous operation during 1975. Byproduct molybdenum will be recovered from the copper porphyry deposit located near Miami, Ariz. At design capacity, the concentrator should produce about 4.8 tons per day of molybdenum concentrate averaging 85% MoS_2. This production rate translates to an annual output of 1.5 to 2 million pounds of molybdenum from the Pinto Valley operation.

Cyprus Bagdad Copper Co., a subsidiary of Cyprus Mines Corp., progressed with expansion work at its Bagdad open pit copper mine in Arizona. Site preparation for the primary crusher and concentrator was completed in 1975. The concentrator will have the capacity to treat 40,000 tons per day of copper-molybdenum ore, a tonnage which should substantially increase the output of byproduct molybdenum from the mine. All major construction was on schedule, and the entire expansion project was expected to be completed late in 1977. Cyprus Bagdad sold over 400,000 pounds of molybdenum in 1975.

Cyprus Mines Corp. also continued to study the potential of its Thompson Creek molybdenum prospect in central Idaho. During 1975, consultants were retained to make capital and operating cost estimates, to study open pit and underground mining methods for the deposit, and to make metallurgical bench-scale and pilot plant tests. Cyprus has spent 8 years on its investigation of the prospect; a decision as to mining feasibility could be made in 1976.

Duval Corp. commenced operation of a newly constructed ferromolybdenum plant adjacent to its Esperanza property near Tucson, Ariz. The facility cost $2 million and will have the capacity to produce 3.5 million pounds of ferromolybdenum per year. Silicothermic reduction of molybdic oxide, supplemented with powdered aluminum, is used to produce the ferromolybdenum.

The Pesses Co. initiated construction of a ferroalloy plant near Pulaski, Pa., in 1975. Completion was scheduled at the end of the first quarter of 1976. In addition to supplying its own requirements, the company planned to produce ferromolybdenum and other ferroalloys on a toll basis. The company is a manufacturer of products for the metalworking and ceramic industries.

Table 2.—Production, shipments, and stocks of molybdenum products in the United States in 1975

(Thousand pounds contained molybdenum)

	Molybdic oxides [1]	Metal powder	Ammonium molybdate	Sodium molybdate	Other [2]	Total
Received from other producers	8,194	9	837	41	20	9,101
Gross production during year	94,175	3,142	3,456	1,196	11,403	113,642
Used to make other products listed here	24,032	459	1,508	127	15	26,141
Net production	70,143	3,064	1,948	1,069	11,388	87,612
Shipments	71,747	3,147	2,074	1,054	11,767	89,789
Producer stocks, Dec. 31	17,130	473	1,347	170	3,743	22,863

[1] Includes technical and purified molybdic oxide and briquets.
[2] Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, molybdenum disulfide, molybdic acid, pellets, molybdenum pentachloride, and molybdenum hexacarbonyl.

CONSUMPTION AND USES

Domestic consumption of molybdenum in concentrate form decreased 1.7 million pounds, 2% less than in 1974. Most of the concentrate, except that purified to lubrication-grade molybdenum disulfide and a small amount added directly to iron and steel furnaces, was roasted to technical-grade molybdic oxide. Molybdic oxide was consumed directly or converted to other molybdenum products.

End-use consumption of molybdenum materials decreased 18.5% compared with that of 1974 (table 3). Nearly all categories of end-use consumption experienced a decline due to the economic situation that prevailed during 1975. Especially significant was the drop in iron and steel production, since that industry utilizes most of the molybdenum consumed each year. Molybdenum consumed during 1975 in the production of full alloy, stainless, tool, and high-strength low-alloy steels declined 7%, 37%, 55%, and 11%, respectively, compared with that of 1974. Total consumption in all steels, cast irons, and superalloys equaled 43,952,000 pounds of molybdenum 17.8% below the 1974 level of consumption. Consumption of molybdenum to manufacture mill products decreased 32% and for chemical and ceramic uses, 24%.

The decrease in molybdenum consumption during 1975 was viewed as temporary by molybdenum industry officials. The marketing of new steels containing molybdenum as an alloying element was expected to augment molybdenum consumption. Among such newly developed products were a group of ferritic stainless steels, which contain 1 to 4% molybdenum. These steels exhibit marked corrosion resistance and were developed for use in hot-water tanks, heat exchangers, water tubing, and for other equipment exposed to severe chemical environments. Increased consumption of molybdenum was expected in high-strength low-alloy steels for large-diameter pipelines and for steel pipe used in drilling oil and gas wells.

Research was directed toward the development of nonmetallurgical uses for molybdenum. Molybdenum is utilized in catalysts for petroleum refining and was expected to find similar use in coal liquefaction and gasification processes. New applications were investigated for purified molybdenum disulfide as a lubricant and as an additive to oil and greases to reduce wear.

Table 3.—Consumption of molybdenum materials, by end use in 1975
(Thousand pounds contained molybdenum)

End use	Molybdic oxides	Ferro-molyb-denum [1]	Ammonium and sodium molybdate	Other molyb-denum materials [2]	Total
Steel:					
Carbon	2,316	464	--	19	2,799
Stainless and heat resisting	4,897	1,331	--	121	6,349
Full alloy	20,933	1,793	--	48	22,774
High-strength low-alloy	2,222	503	--	43	2,768
Electric	389	54	--	--	443
Tool	1,675	603	--	14	2,292
Cast irons	973	3,124	--	102	4,199
Superalloys	1,050	303	--	975	2,328
Alloys (excludes steel and superalloys):					
Welding and alloy hard-facing rods and materials	--	397	--	43	440
Other alloys [3]	90	428	--	99	617
Mill products made from metal powder	--	--	--	2,054	2,054
Chemical and ceramic uses:					
Pigments	409	--	406	10	825
Catalysts	1,724	--	W	--	1,724
Other	71	9	--	757	837
Miscellaneous and unspecified	252	135	549	358	1,294
Total	37,001	9,144	955	4,643	51,743
Consumer stocks Dec. 31	4,036	1,416	127	1,242	6,821

W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."
[1] Includes calcium molybdate.
[2] Includes purified molybdenum disulfide, molybdenite concentrate added directly to steel, molybdenum metal powder, molybdenum metal pellets, and other molybdenum materials.
[3] Includes magnetic and nonferrous alloys.

STOCKS

At the close of 1975, industry stocks of molybdenum totaled 40.3 million pounds, 14% less than at yearend 1974. Molybdenum in stocks at mines and plants decreased 43%, those at producer plants increased 42%, but those at consumer plants decreased 44% compared with 1974 figures.

PRICES

Published prices for molybdenum concentrate and other molybdenum products increased twice during 1975, once at the beginning of the year and again at the end of September. The price of Climax concentrate increased 14% and averaged $2.48 per pound of contained molybdenum during the year. Reportedly, higher operating costs and expenditures for expansion of mining and production facilities accounted for the increase in molybdenum prices. Yearend prices as published in Metals Week for molybdenum products per pound of contained molybdenum follow:

Climax concentrate	$2.62
Byproduct concentrate	$2.20–2.55
Climax oxide/cans	2.90
Dealer oxide	2.90–2.95
K–1 oxide/cans	2.90
K–2 oxide/cans	2.83
Ferromolybdenum/Climax lump	3.44
Ferromolybdenum/Climax powder	3.50
Ferromolybdenum/dealer export	3.45–3.50

FOREIGN TRADE

Exports.—Exports of molybdenum in concentrate and oxide totaled 62.6 million pounds in 1975, 20% less than in 1974. This quantity represented about 59% of U.S. production for the year. The Netherlands, Belgium-Luxembourg, Japan, and West Germany received 84% of the exports of molybdenum in concentrate and oxide forms. Compared with the export level in 1974, the decrease in exports in 1975 was due to decreased demand associated with the economic recession that affected most industrialized nations in 1975. Despite the decrease in quantity exported, the total value of molybdenum concentrate and oxide exports increased about 6% to $159.6 million in 1975.

Exports of ferromolybdenum totaled 2,241,000 pounds, 45% less than in 1974. Canada and Japan received 46% of the ferromolybdenum exported. The total value of ferromolybdenum exported was $4.8 million, down from $7.1 million in 1974.

Other molybdenum materials exported in 1975 included metals and alloys in crude form and scrap, wire, powder, and semifabricated forms. The gross weight of these materials was 959,000 pounds compared with 974,000 pounds in 1974; total value was $5.8 million compared with nearly $6.9 million in 1974.

Imports.—In general, a relatively small quantity of molybdenum enters the United States each year as imported material. Molybdenum imports during 1975 included concentrate, ferromolybdenum, metal products, waste and scrap, and chemicals. The total value of these materials rose to $7.7 million compared with $2.6 million in 1974.

The large increase in value of imported molybdenum materials is attributable to significantly greater imports of concentrate in 1975. The molybdenum contained in imports of concentrate totaled 2,566,680 pounds compared with 155,124 pounds in 1974. The value of concentrate imports during 1975 was about $5.9 million or approximately $2.30 per pound of contained molybdenum. Concentrate was imported from Canada, Chile, Peru, and the Philippines. Canada supplied 74% of the concentrate.

A small quantity of ferromolybdenum containing 3,493 pounds of molybdenum and valued at $10,266 was imported from the United Kingdom and Canada. Imports of 43,084 pounds (gross weight) of wrought and unwrought metal valued at $448,079 came from eight countries. Austria supplied 71% of the metal. Material in which the chief value is molybdenum was imported from the Netherlands and Japan. This material contained 71,983 pounds of molybdenum, valued at $463,112. The gross weight of waste and scrap imported from four countries was 44,672 pounds, valued at $101,073.

Molybdenum chemicals and related products that entered the United States during 1975 included ammonium molybdate containing 50,324 pounds of molybdenum and valued at $154,834; molybdenum compounds containing 73,260 pounds of molybdenum and valued at $198,832; mixtures containing 6,019 pounds of molybdenum and valued at $73,084; and 469,050 pounds (gross weight) of molybdenum orange valued at $317,774. Canada, Chile, and the Netherlands were the chief suppliers of molybdenum chemicals in 1975.

Table 4.—Molybdenum reported by producers as shipments for export from the United States

(Thousand pounds contained molybdenum)

Product	1974	1975
Molybdenite concentrate	39,965	36,618
Molybdic oxide	35,949	31,210
All other primary products	2,921	1,874

Table 5.—U.S. exports of molybdenum ore and concentrates (including roasted concentrates), by country

(Thousand pounds contained molybdenum and thousand dollars)

Country	1974		1975	
	Quantity	Value	Quantity	Value
Argentina	40	96	45	95
Australia	425	797	--	--
Austria	--	--	87	247
Belgium-Luxembourg	10,389	19,202	11,156	28,820
Brazil	1,089	2,188	950	2,507
Canada	2,230	4,233	1,157	2,717
France	468	723	820	2,265
Germany, West	7,783	14,792	6,398	14,746
India	106	195	167	462
Italy	--	--	109	294
Japan	13,380	26,303	9,217	25,107
Mexico	883	1,297	1,492	2,642
Netherlands	35,103	69,764	26,131	67,645
New Zealand	18	41	11	28
Philippines	242	486	15	41
South Africa, Republic of	461	798	159	377
Spain	247	565	93	152
Sweden	2,511	3,777	1,852	4,427
Switzerland	56	115	145	373
United Kingdom	2,814	5,070	2,520	6,264
Venezuela	396	600	77	359
Other	19	33	10	24
Total	78,660	151,075	62,611	159,592

Table 6.—U.S. exports of molybdenum products

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1974		1975	
	Quantity	Value	Quantity	Value
Ferromolybdenum: [1]				
Argentina	132	216	76	216
Australia	644	1,044	240	538
Brazil	32	41	3	5
Canada	589	975	594	929
Colombia	31	44	16	33
Germany, West	93	160	--	--
India	185	352	114	264
Italy	--	--	214	487
Japan	2,117	3,876	445	1,090
Mexico	10	23	161	420
Netherlands	--	--	52	122
Pakistan	11	16	--	--
Peru	21	34	4	16
South Africa, Republic of	177	237	127	301
Spain	43	61	22	52
Sweden	--	--	95	214
Taiwan	4	6	11	23
Turkey	--	--	24	17
United Kingdom	--	--	43	71
Other	5	9	--	--
Total	4,094	7,094	2,241	4,798
Metal and alloys in crude form and scrap:				
Argentina	3	12	--	--
Belgium-Luxembourg	7	54	--	--
Canada	5	2	18	4
France	5	17	--	--
Germany, West	23	40	56	187
Japan	17	34	76	221
Mexico	--	--	20	67
South Africa, Republic of	39	70	48	88
Switzerland	--	--	51	89
United Kingdom	([2])	1	44	185
Other	6	26	4	17
Total	105	256	317	858

See footnotes at end of table.

Table 6.—U.S. exports of molybdenum products—Continued

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1974		1975	
	Quantity	Value	Quantity	Value
Wire:				
Argentina	6	72	2	33
Australia	13	96	6	55
Belgium-Luxembourg	29	177	9	66
Brazil	39	409	15	237
Canada	43	494	51	508
Finland	1	15	--	--
France	42	338	19	202
Germany, West	112	848	77	623
India	(2)	21	(2)	4
Israel	33	211	7	44
Italy	6	56	6	50
Japan	31	257	35	274
Mexico	4	86	6	143
Netherlands	13	478	5	185
Philippines	1	34	(2)	10
Singapore	(2)	13	4	86
Spain	14	97	12	83
United Kingdom	17	370	12	213
Other	11	138	4	47
Total	415	4,210	270	2,863
Powder:				
Argentina	9	38	--	--
Canada	2	7	7	28
Germany, West	1	7	14	51
Italy	--	--	2	12
Japan	78	241	(2)	2
Netherlands	61	242	--	--
Spain	(2)	1	(2)	7
Sweden	36	153	28	157
Switzerland	(2)	1	(2)	7
United Kingdom	11	18	5	14
Other	5	20	4	18
Total	203	728	60	296
Semifabricated forms, n.e.c.:				
Australia	33	89	1	12
Belgium-Luxembourg	3	28	(2)	8
Brazil	6	36	2	26
Canada	19	130	19	198
France	7	125	18	150
Germany, West	24	144	28	208
Guatemala	4	29	--	--
Honduras	--	--	79	38
India	6	46	9	36
Italy	5	73	3	61
Japan	14	167	5	65
Korea, Republic of	1	47	--	--
Mexico	3	33	67	158
Netherlands	15	174	6	134
South Africa, Republic of	14	109	28	234
Sweden	(2)	5	(2)	37
Taiwan	1	15	(2)	1
United Kingdom	93	379	42	374
Other	3	41	5	50
Total	251	1,670	312	1,790

[1] Ferromolybdenum contains about 60% to 65% molybdenum.
[2] Less than ½ unit.

Table 7.—U.S. import duties

Item	Article	Rate of duty, Jan. 1, 1976 [1]
601.33	Molybdenum ore	12 cents per pound on molybdenum content.
603.40	Material in chief value molybdenum	10 cents per pound on molybdenum content plus 3% ad valorem.
607.40	Ferromolybdenum	Do.
	Molybdenum:	
628.70	Waste and scrap	10.5% ad valorem.[2]
628.72	Unwrought	10 cents per pound on molybdenum content plus 3% ad valorem.
628.74	Wrought	12.5% ad valorem.
	Molybdenum chemicals:	
417.28	Ammonium molybdate	10 cents per pound on molybdenum content plus 3% ad valorem.
418.26	Calcium molybdate	Do.
419.60	Molybdenum compounds	Do.
420.22	Potassium molybdate	Do.
421.10	Sodium molybdate	Do.
423.88	Mixtures of inorganic compounds, chief value molybdenum	Do.
473.18	Molybdenum orange	5% ad valorem.

[1] Not applicable to countries that have centrally controlled economies.
[2] Duty on waste and scrap temporarily suspended.

WORLD REVIEW

World molybdenum production decreased about 10.4 million pounds compared with that of 1974. The decline was primarily due to lower byproduct recovery of molybdenum at copper operations. Molybdenum production of 155.3 million pounds by market economy countries was principally from the United States (68%), Canada (18%), and Chile(13%).

Canada.—Estimated production of molybdenum declined 3,322,000 pounds in 1975, 11% lower than in 1974. About half of the Canadian output was byproduct molybdenum produced at copper mining operations. The weak worldwide market for copper in 1975 resulted in a decrease in copper output and a corresponding decrease in molybdenum production. Nevertheless, Canada continued to be the second leading world producer of molybdenum.

Exploratory and developmental work on molybdenum properties continued at several sites in the western provinces of Canada. Vestor Explorations, Ltd., carried on exploratory drilling at its Carmi molybdenum prospect south of Kelowna, British Columbia. It was reported that the property may contain a potential 100 million tons of molybdenite ore. Further exploration to outline mineralized zones was scheduled for 1976.

Dynamic Mining Exploration, Ltd., expanded its Thelon-Dazan project holdings in the Baker Lake area of the Northwest Territories. Substantial uranium and molybdenum mineralization has been discovered, and additional drilling was planned to determine the value of the prospect.

Brynnor Mines Ltd., a subsidiary of Noranda Mines Limited conducted a feasibility study on open pit mining of its Boss Mountain property, which is currently mined by underground methods. The low-grade molybdenum reserves amenable to open pit recovery were estimated at over 40 million tons. The mine reportedly contained sufficient high-grade ore reserves to permit mining operations at the present level until the latter part of 1977.

Kitla Exploration, Ltd., was investigating a molybdenum-uranium prospect on a 1,200-acre lease near Black Lake, Saskatchewan. Trenches were excavated to expose the mineralized zone, which reportedly is workable by open pit mining methods.

Climax Molybdenum Co. of British Columbia, Ltd., a subsidiary of AMAX Inc., U.S.A., extended its lease on the Ruby Creek prospect near Atlin, British Columbia. The property has been leased by Climax from Adanac Mining and Exploration, Ltd., since 1973, and about $500,000 has been spent on drilling and other investigative work.

Climax also purchased the Roundy Creek prospect in the Alice Arms area from United Chieftain Resources, Ltd. The property reportedly was obtained for about $300,000 and a royalty on future production at a rate of 5 cents per pound of contained molybdenum. At the nearby Kitsault, British Columbia, property, Climax also was considering a resumption of molybdenum mining. The mine and associated concentrator, formerly owned by Kennecott Copper Corp., has been inoperative since 1972.

Chile.—Compañía Minera Andina, a State-owned Chilean company, announced plans to build a molybdenite plant with an annual output capacity of about 770,000 tons. Financing for the construction will come from a $14 million loan from Japan's Sumitomo Metal Mining Corp., Ltd. No date for construction or expected operation was scheduled.

Greenland.—Nordisk Mineselskab A/S reportedly sought an extension of a lease from the Government of Denmark on a molybdenum prospect near Mastersvig, Greenland. Reevaluation of drilling data and other information indicated that further exploration on the property was warranted.

Mexico.—Mexxon Mines Ltd. continued exploration of its El Palmor copper-molybdenum-tungsten deposit in northern Mexico. During 1974, the company completed exploratory drilling of two large structural anomalies on the property and low-grade mineralization was encountered. Extensive geochemical surveys were underway during 1975 to locate additional target areas.

New Zealand.—A drilling program was started by New Zealand Cities Service Ltd. to explore the Taipo molybdenum prospect. The property is located northeast of Nelson on the South Island.

Peru.—Mina Aquila S.A., a newly organized private corporation, secured a $3 million loan to develop a copper-molybdenum deposit near Chimbote, in the province of Sihaus. The funds, obtained from the Export Development Corp., will be used principally to purchase engineering services and mine and concentrator equipment from various Canadian concerns.

Table 8.—Molybdenum: World mine production by country
(Thousand pounds contained molybdenum)

Country [1]	1973	1974	1975 p
Australia e	2	25	25
Bulgaria e	310	310	310
Canada (shipments)	30,391	30,736	27,414
Chile	12,974	21,466	20,042
China, People's Republic of e	3,300	3,300	3,300
Japan	345	235	309
Korea, Republic of	112	166	166
Mexico	90	95	37
Norway	r 220	--	--
Peru	r 1,395	1,530	e 1,300
Portugal	(2)	e (2)	e (2)
U.S.S.R. e	18,700	19,400	20,000
United States	115,859	112,011	105,980
Total	r 183,698	189,274	178,883

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed, Argentina, North Korea, Nigeria, Romania, South-West Africa, and Spain also produce molybdenum, but information is inadequate to make reliable estimates of output levels.
[2] Less than ½ unit.

TECHNOLOGY

Bureau of Mines researchers developed a method for separating and extracting molybdenum and rhenium from an aqueous solution derived by electrooxidation of sulfide minerals.[2] Previous experiments had shown that the extraction of 98% to 99% of the molybdenum and rhenium from low-grade molybdenite concentrates by an electrooxidation process was technically feasible. In the current investigation, molybdenum and rhenium were extracted from an electrooxidation process solution with a tertiary amine solvent. Results indicated that essentially all of the molybdenum and rhenium was extracted by the solvent and that greater than 90% of the molybdenum could be recovered from the column effluent. The final $(NH_4)ReO_4$ product contained less than 80 parts per million impurities.

Cyprus Mines Corp. developed a process for separating talc from molybdenite more

[2] Fischer, D. D., D. J. Bauer, and R. E. Lindstrom. Recovery and Separation of Molybdenum and Rhenium From a Process Solution. BuMines RI 8088, 1975, 12 pp.

efficiently.[3] The slurry, which remains after copper values have been extracted, is treated with a water-soluble salt of a weak base and strong acid (such as aluminum sulfate), then with a water-soluble salt of a weak acid (such as sodium silicate). Talc or other hydrophobic magnesium silicates are depressed while molybdenite is removed by froth flotation. The process has been used since 1971 at the copper mining facilities operated by Cyprus Pima Mining Co. and has replaced conventional roasting and talc flotation techniques.

The Metallurgical Research Dept. of The Anaconda Company developed a system using lignin sulfonate to separate molybdenite from clays and talc.[4] In the system, a primary circuit initially separates copper minerals from molybdenite and other floatable constituents of the bulk ore. The molybdenum concentrate is then treated with milk-of-lime (CaO) and large quantities of lignin sulfonate, which selectively depresses molybdenite. Tests indicated that recovery of molybdenum exceeded 95% at about pH 11.9; the upgraded concentrate contained about 45% molybdenum. The process performs best on silicates and clay; recovery and grade of molybdenum decline as the proportion of carbonates and sulfates in the original concentrate increased. Anamax Mining Co., a partnership of The Anaconda Company and AMAX Inc., tested and utilized the process at its Twin Buttes copper operations in Arizona.

The properties of molybdenum disulfide and its behavior as a dry lubricant and as a constituent in suspensions and greases were reviewed.[5] Lubricating effects of MoS_2 as a bonded film and as a matrix material in plastics and metals were also discussed. Additions of a small amount of graphite or antimony trioxide was found to enhance the performance of MoS_2 in many lubrication applications. A mechanism of oxide interaction has been proposed to explain the improved quality of these mixed solid lubricants.[6]

For a number of years, investigations have been conducted on evaluating the effect of MoS_2 additions to engine oil on automotive performance. A review of these studies and recent experimental results were published.[7] Statistical analysis of fuel consumption data indicated an average improvement in fuel consumption of 4.4% due to a 1% weight addition of MoS_2 to engine oil. The MoS_2 additions appeared to decrease engine wear and sludge accumulation, while not adversely affecting emission levels.

The beneficial effects of MoS_2 on the mechanical properties of thermoplastics was reviewed.[8] The properties of polymer-MoS_2 composites were discussed with respect to crystallinity of polymers, bonding interaction between MoS_2 and polymers, and polymer properties as affected by the size, shape, and surface of MoS_2 particles.

The potential of molybdenum compounds as flame retardants and smoke suppressants was examined.[9] Laboratory tests showed that additions of molybdenum trioxide to a plasticized polyvinyl chloride (PVC) significantly decreased the flammability and smoke generation of a burning sample. Similar improvements were obtained on polyester samples treated with molybdenum trioxide and ammonium molybdates. The best results were achieved when molybdenum compounds were used in combination with antimony trioxide or aluminum trihydrate.

Patent activity during 1975 was concerned with methods of upgrading and refining molybdenite ores. Patents were granted for the recovery of molybdenum from roasted molybdenite concentrate by acid leaching;[10] for the separation of molybdenite from other sulfides in flotation concentrates by roasting with silica sand;[11] for the recovery of molybdenum from copper reverberatory furnace slag;[12] for a new

[3] Chemical Week. Chemicals Are Solution to Ore Separation. V. 118, No. 8, Feb. 25, 1976, p. 36.
[4] Hiscox, T. O., Dr. M. C. Kuhn, and T. B. Buza. Use of Lignin Sulphonate as Moly Depressant Boosts Recovery at Twin Buttes. Eng. Min. J., v. 176, No. 4, April 1975, pp. 87–91.
[5] Farr, J. P. G. Molybdenum Disulphide in Lubrication—A Review. Wear, v. 35, 1975, pp. 1–22.
[6] Lavik, M. T., R. D. Hubbell, and B. D. McConnell. Oxide Interaction—A Concept for Improved Performance With Molybdenum Disulfide. Lubrication Eng., v. 31, No. 1, January 1975, pp. 20–27.
[7] Risdon, T. J., and D. A. Gresty. An Historical Review of Reductions in Fuel Consumption of United States and European Engines With MoS_2. Pres. at Fuels and Lubricants Meeting, SAE, Houston, Tex., June 3–5, 1975, SAE Preprint 750674, 16 pp.
[8] Braithwaite, E. R. Some Thoughts on the Effects of MoS_2 on the Mechanical Properties of Thermoplastics. Wear, v. 34, 1975, pp. 455–465.
[9] Church, D. A., and F. W. Moore. Molybdenum-Based Flame Retardants Are Now in the Plastics Ball Game. Plastics Engineering, v. 31, No. 12, December 1975, pp. 36–38.
[10] Weber, T. A., and R. F. Borrman (assigned to Hermann C. Starck Berlin). Recovery of Molybdenum. U.S. Pat. 3,860,419, Jan. 14, 1975.
[11] Last, A. W., and G. L. Fraser (assigned to Kennecott Copper Corp.). Upgrading of Molybdenite. U.S. Pat. 3,871,867, Mar. 18, 1975.
[12] Ammann, P. R. (assigned to Kennecott Copper Corp.). Recovery of Molybdenum Values. U.S. Pat. 3,896,210, July 22, 1975.

roasting apparatus to recover high-purity molybdenum trioxide from concentrate;[13] for a process that selectively removes oxidized metal impurities by alkaline leaching of molybdenite concentrate;[14] for the separation of molybdenite from copper sulfide ore concentrate using lignin sulfonate to depress molybdenite;[15] for the froth flotation separation of molybdenite from gangue, which includes talc or other hydrophobic magnesium sillicates;[16] and for the recovery of molybdenite or other sulfide values from ores containing clays or talc by froth flotation.[17]

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[13] Jemal, E. J. Apparatus for Recovering Molybdenum Values. U.S. Pat. 3,910,767, Oct. 7, 1975.

[14] Probert, T. I., K. J. Richards, C. N. Wright, and G. E. Entrop (assigned to Kennecott Copper Corp.). Process for Removing Oxidized Metal Impurities From Molybdenite Concentrate. U.S. Pat. 3,911,076, Oct. 7, 1975.

[15] Buza, T. B., and M. C. Kuhn (assigned to The Anaconda Company). Froth Flotation Separation of Molybdenite. U.S. Pat. 3,912,623, Oct. 14, 1975.

[16] Huch, R. O., and P. Valles (assigned to Pima Mining Co.). Froth Flotation Beneficiation of Molybdenite. U.S. Pat. 3,921,810, Nov. 25, 1975.

[17] Weston, D. Froth Flotation Beneficiation of Sulfide Ores. U.S. Pat. 3,919,079, Nov. 11, 1975.

Natural Gas

By Gordon W. Koelling [1] and Leonard L. Fanelli [2]

Marketed production of natural gas in the United States declined approximately 1.5 trillion cubic feet (Tcf) to 20.1 Tcf in 1975. This 6.9% decrease, the second consecutive annual decrease and only the second decrease since 1938, followed the rapid depletion of the Nation's proved natural gas reserves during recent years.

Total consumption of natural gas (including extraction losses) in 1975 was 20.4 Tcf, 7.7% less than in 1974. The industrial sector, the largest user of natural gas, experienced the greatest decline, 1.3 Tcf, and the electric utilities sector registered a decrease of almost 0.3 Tcf. Declining consumption in those sectors during 1975 was related to a 39.1% increase in the net curtailments of firm delivery commitments by pipeline companies and to a general decline in the Nation's economic activity. Residential use of natural gas increased 138 billion cubic feet (Bcf); growth in the commercial sector was insignificant.

Table 1.—Salient statistics of natural gas in the United States

	1971	1972	1973	1974	1975
Supply:					
Marketed production [1] million cubic feet	22,493,012	22,531,698	22,647,549	21,600,522	20,108,661
Withdrawn from storage do	1,507,630	1,757,218	1,532,820	1,700,546	1,759,565
Imports do	934,548	1,019,496	1,032,901	959,284	953,008
Total do	24,935,190	25,308,412	25,213,270	24,260,352	22,821,234
Disposition:					
Consumption do	22,676,581	23,009,445	22,965,914	22,110,623	20,409,875
Exports do	80,212	78,013	77,169	76,789	72,675
Stored do	1,839,398	1,892,952	1,974,324	1,784,209	2,103,619
Unaccounted for do	338,999	328,002	195,863	288,731	235,065
Total do	24,935,190	25,308,412	25,213,270	24,260,352	22,821,234
Value at wellhead:					
Total thousand dollars	4,085,482	4,180,462	4,894,072	6,573,402	8,945,062
Average cents per thousand cubic feet	18.2	18.6	21.6	30.4	44.5

[1] Marketed production of natural gas represents gross withdrawals less gas used for repressuring and quantities vented and flared.

NOTE.—Domestic production as used in the Bureau publication "Minerals and Materials/monthly survey" represents marketed production less the shrinkage (extraction loss) resulting from the extraction of natural gas liquids.

Proved reserves of natural gas declined 3.8% from 237.1 Tcf at yearend 1974 to 228.2 Tcf by yearend 1975 as annual discoveries failed to equal production for the seventh time in the last 8 years. Extensions to known fields during 1975 totaled 6 Tcf, and new reservoir discoveries in old fields and new field discoveries accounted for 4.1 Tcf. Revisions of previous reserve estimates and changes in underground storage resulted in a net addition of 0.7 Tcf.

The average wellhead value of natural

[1] Mineral specialist, Division of Petroleum and Natural Gas.
[2] Survey statistician, Division of Fuels Data.

gas increased 46.4% to 44.5 cents per thousand cubic feet (Mcf) in 1975. During the same year, the average retail price for gas delivered to consumers rose 33.4% to 119.3 cents per Mcf.

Exports of 73 Bcf in 1975 were 5.4% less than in 1974. About 72.9% of total 1975 exports was shipped from Alaska to Japan as liquefied natural gas (LGN). The remaining exports, which were transported by pipeline, were almost equally divided between Canada and Mexico.

Natural gas imports declined slightly to 953 Bcf in 1975. Almost all of this gas was shipped from Canada via pipeline. LNG shipments from Algeria totaled only about 5 Bcf and, for the first time since 1955, no imports were received from Mexico.

Efforts to supplement natural gas supplies through the gasification of liquid fuels continued. Eleven such plants were operational, two were under construction, and two were planned as of yearend 1975.

Six pilot projects for the development and testing of processes for the production of high-Btu gas from coal were operational or under construction at yearend 1975. An additional three projects involving the production of low-Btu gas from coal were also operational or under construction. The Bureau of Mines continued its experimental coalbed degasification project during the year. Several gasification projects involving biomass conversion were also under development.

Research programs involving fracturing techniques to stimulate flow from economically submarginal gas reservoirs, including these in the Upper Devonian shales of the Eastern United States, were in progress. The U.S. Geological Survey initiated studies of the methane saturated Gulf Coast salt water aquifers penetrated by a number of onshore wells.

The Federal Power Commission (FPC), which regulates the sale, transportation, and price of gas moved in interstate commerce, continued to apply a single uniform national base rate for interstate natural gas sales by producers. As of late 1975, the single uniform national base rate had escalated to 52 cents per Mcf. This rate applied to gas from wells commenced since January 1, 1973, and to new dedications of gas to interstate commerce since that date.

Leasing of Federal lands for the exploration and development of natural gas (and crude oil) resources continued under the authority of various public land acts. In 1975, the Federal Government leased 1.7 million acres on the Gulf of Mexico Outer Continental Shelf and off southern California for bonus bids totaling approximately $1 billion. An additional 1.3 million acres off the southern California coast were offered for lease sale in December 1975.

Notice of a proposed regulation to establish emergency procedures for granting priorities and allocating natural gas under the Defense Production Act of 1950, to assure adequate gas supplies for vital defense activities, was issued by the Department of the Interior during 1975. This regulation would be applicable only in exceptional cases where, in the event of actual or imminent shortages, FPC and the appropriate State regulatory commission lack jurisdiction to direct delivery of natural gas to meet defense needs.

The Office of Pipeline Safety (OPS), responsible for safety regulation of natural gas pipelines, reported that the total number of pipeline failures declined 7% during 1975, and that the number of fatalities resulting from these failures decreased from 24 to 14. Damage by outside forces was the cause of 71.4% of total failures (table 2).

Federal gas pipeline safety standards, contained in Part 192 of Title 49 of the Code of Federal Regulations, were amended to provide for the transportation of double-jointed pipe by railroad, to update welding and weld inspection requirements, to improve specifications for plastic pipe, to prescribe new marketing requirements for gas pipelines, and to establish requirements for odorization of gas in transmission lines. Notices of proposed rulemakings were issued with respect to emergency plans, cast iron pipelines, offshore pipeline, pipe-bending limitations, and the updating of documents incorporated by reference in Part 192.

DOMESTIC PRODUCTION

Gross withdrawals of natural gas (table 3), including marketed production, gas returned to the formation for pressure maintenance, and that vented or flared; totaled 21.1 Tcf in 1975, approximately 7.6% less than in 1974. Marketed production declined 6.9% to 20.1 Tcf during 1975, and the quantity of gas used for repressuring decreased 20.3% to about 0.9 Tcf. Quantities vented and flared dropped 20.9% to 0.1 Tcf.

Gross withdrawals from gas wells declined 6.9% in 1975 to 17.4 Tcf, and gas withdrawals from oil wells dropped 10.9% to 3.7 Tcf. Increased gross withdrawals were registered by only 7 of the 31 producing States and the quantities involved were small. The largest gain, 23.3 Bcf, was in Alaska.

The combined decrease in gross withdrawals registered by the two largest producing States, Texas and Louisiana, was equivalent to approximately 89% of the country's total net decline in 1975. Texas showed a decline of 9.8%, almost two-thirds of which was accounted for by a drop in production from gas wells; Louisiana registered a decrease of 8.6%, most of which also was due to a decline in gas well production.

Almost three-fourths of the total marketed natural gas production was from Texas and Louisiana. Marketed production data for leading producing States are shown in the following tabulation:

State	Marketed production in 1975 (Bcf)	Change from 1974 (percent)	Percent of total U.S. marketed production in 1975
Texas	7,486	−8.4	37.2
Louisiana	7,091	−8.6	35.3
Oklahoma	1,605	−2.0	8.0
New Mexico	1,217	−2.2	6.1
Kansas	844	−4.9	4.2
California	318	−12.9	1.6
Wyoming	316	−3.2	1.6
Others	1,232	+1.5	6.0
Total	20,109	−6.9	100.0

Gas well completions (table 4) in 1975 totaled 7,580, a net increase of 341, or 4.7%, over that of 1974. The largest increase in gas well completions, 292, occurred in Texas where continuing development of the Laredo field and exploratory and development drilling in the Ozana-Sonora area in the southwest part of the State were partially responsible for increased activity. Other significant increases in completions were in Pennsylvania (172) and Montana (134), where most wells are relatively small producers. In Ohio, where a large number of shallow wells were drilled during recent years, the number of gas well completions fell sharply from 1,050 in 1974 to 555 in 1975.

Completions of exploratory wells (table 5) in 1975 decreased 1.9% to 1,171. Texas accounted for 48.8% of these completions.

Data on gas well completions include condensate wells. The latter are wells that produce from high-pressure natural gas reservoirs, some of which contain considerable quantities of liquid hydrocarbons in the pentanes and heavier range described generically as "condensate."

The number of gas and condensate wells producing at yearend 1975 totaled 130,364 (table 6). This was an increase of 3.2% over the 1974 yearend total and 11% more than the number of wells producing at yearend 1970.

CONSUMPTION AND USES

Consumption (wet) of natural gas in 1975 totaled 20.4 Tcf, a 7.7% decrease from 1974 (table 7). Gas delivered to consumers declined 8% to 17.6 Tcf during 1975 when it accounted for 86% of total consumption (table 8). Of the remainder, 6.8% was used as lease and plant fuel, 2.9% was used for pipeline fuel, and 4.3% was accounted for by extraction losses (shrinkage) at gas-processing plants.

Residential use increased 2.9% to 4,924 Bcf in 1975 when it accounted for 28% of total deliveries to consumers. Most of the rise in residential use occurred in the contiguous Pacific, Mountain, and West South Central census regions.

The increase in the total number of residential consumers during 1975 was insignificant. Data on the number of residential customers by Census Regions for the years 1965, 1974, and 1975 are as follows:

Census regions	Residential consumers (thousands)		
	1965	1974	1975
New England	1,504	1,623	1,626
Middle Atlantic	7,381	7,779	7,594
East North Central	8,011	9,439	9,493
West North Central	3,005	3,519	3,587
South Atlantic	2,926	3,569	3,597
East South Central	1,684	2,001	1,967
West South Central	4,017	4,811	4,698
Mountain	1,523	2,151	2,227
Pacific	5,251	6,617	6,727
Total	35,302	41,509	41,516

The use of gas by the commercial sector increased slightly to 2,268 Bcf in 1975 despite a 1.2% decline in the number of customers. This sector accounted for 12.9% of total deliveries to consumers.

The industrial sector remained the largest user of natural gas, accounting for 39.7% of 1975 deliveries to consumers. However, total consumption by this sector dropped 16% to 6,979 Bcf during the year. Relatively low economic activity and curtailments of deliveries by many interstate pipelines contributed to this abrupt decline. Most of the gas used by industry was consumed as fuel. Petroleum refineries, which used 946 Bcf, and primary metal industries, which used an estimated 850 Bcf, were the principal fuel-consuming industrial sectors. Other important industrial users of gas for fuel included the nonmetallic, paper, and food products sectors. The principal nonfuel use of gas involved the chemicals industry, which used it as a feedstock, primarily in the production of fertilizers and plastics. In 1975, an estimated 1,300 Bcf was used by the chemicals industry both as feedstock and for fuel.

Use of natural gas in the electric utilities industry continued to decline in 1975 when consumption by this sector dropped 8.2% to 3,147 Bcf. The decrease was greatest in the West North Central region where consumption declined 100 Bcf, but decreases were registered in all regions except the West South Central where an increase of 201 Bcf occurred.

The decline in natural gas supply during 1975 forced many gas-distributing companies to deny service to new customers and to curtail supplies to some existing users (tables 10–12). FPC reported that net curtailments of firm delivery commitments of the major interstate pipeline companies for the year April 1975 through March 1976 totaled 2,801 Bcf, a deficiency of 19.7%. Net interruptible curtailments for the same period were reported at 330 Bcf, a deficiency of 54.8%. Firm curtailments for the year ending March 1976 were 39.1% higher than those for the preceding period and interruptible curtailments rose 40.6%.

The milage of field and gathering, transmission, and distribution pipelines in service at the end of 1975 was up only 0.6% from that of the previous year. Most of this increase was due to an increase in the milage of gas distribution mains, which reflected the continuing expansion of the gas utility industry into less densely populated areas. Data on the nations natural gas pipeline network are as follows, in miles:

10^3 miles

	1963	1973 r	1974 r	1975
Field and gathering	60.7	65.9	66.4	68.5
Transmission	200.9	263.1	262.2	262.6
Distribution	448.3	638.8	645.6	648.9
Total	709.9	962.8	974.2	980.0

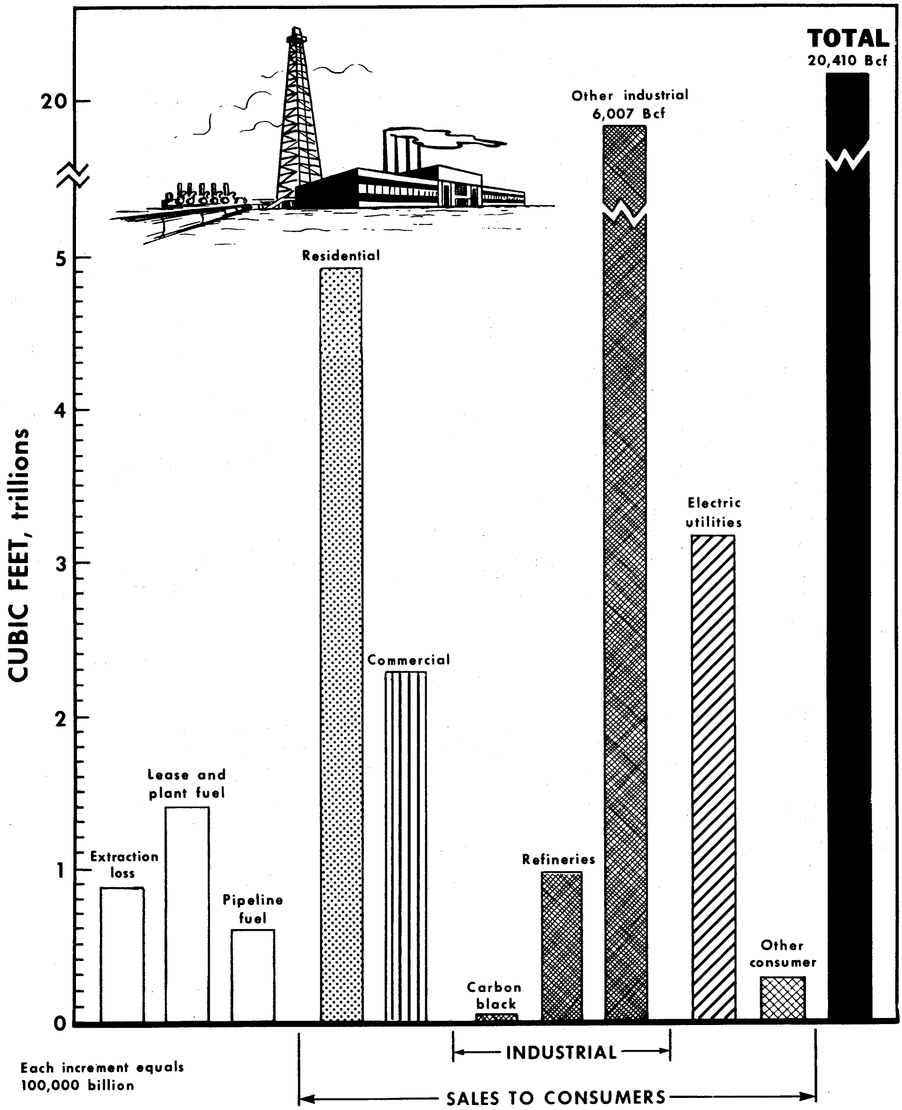

Figure 1.—Disposition of natural gas consumed in the United States by principal use.

RESERVES

Discoveries of natural gas failed to equal production during 7 of the last 8 years, and proved reserves declined 22% during the period. In 1975, the quantity of gas discovered was considerably less than that produced, and proved reserves dropped 3.8% from 237.1 Tcf at yearend 1974 to 228.2 Tcf by yearend 1975, according to the Committee on Natural Gas Reserves of the American Gas Association (AGA).

Additions to proved reserves reported for the United States in 1975 aggregated nearly 10.8 Tcf, approximately 21% more than in 1974 (table 15). Almost 57% of net additions to reserves in 1975 were offshore in the Gulf of Mexico. The largest addition to reserves, 6 Tcf, involved extensions to known fields. Approximately 53% of these new reserves were in Louisiana and Texas. Almost 50% of the 2.4-Tcf total for new field discoveries were in Louisiana (including offshore). New reservoir discoveries in old fields totaled approximately 1.7 Tcf, over 73% of which was in Texas and Louisiana. Net revisions of previous reserve estimates and net changes in underground storage accounted for the remaining 0.7 Tcf of reserve additions.

There were some net increases during 1974 in the reserves of natural gas in 18 States. However, significant increases occurred in only three States, Kansas with almost 1 Tcf (accounted for almost entirely by revisions), and Alabama and California with approximately 0.3 Tcf each. Reserves in Texas dropped 7.5 Tcf, or 9.6%; those in Louisiana declined 2.7 Tcf, or 4.3%.

Natural gas reserves committed to interstate pipelines declined during 1975 for the eighth consecutive year. Dedicated domestic reserves dropped 10.1% in 1975, and domestic gas produced and purchased by interstate pipelines declined 6.9% from the 1974 total of 13.0 Tcf to 12.1 Tcf in 1975. The reserve-production ratio for interstate reserves dropped from 9.3 at yearend 1974 to 9.0 by yearend 1975. Additional data are shown in the following tabulations:

Preliminary summary of domestic natural gas reserves, interstate natural gas pipeline companies
(Billion cubic feet at 14.73 psia and 60° F)

Total dedicated gas reserves as of December 31, 1974	r 120,543
Revisions and additions during 1975	—95
Gas reserves as of December 31, 1974, and changes during 1975	120,448
Gas produced during 1975	12,068
Total dedicated gas reserves as of December 31, 1975	108,380

r Revised.

Yearend domestic reserves, production and purchases of interstate natural gas pipeline companies
(Billion cubic feet at 14.73 psia and 60° F)

	Major supply companies	Minor supply companies	Total
Number of companies	26	34	60
Gas reserves at yearend:			
Company-owned	10,633	526	11,159
Independent producer contracts	95,707	1,517	97,221
Total	106,340	2,043	108,380
Percent of total	98.1	1.9	--
Annual production and purchases:			
Company-owned	633	56	689
Independent producer contracts	11,171	208	11,379
Total	11,804	264	12,068
Percent of total	97.8	2.2	--

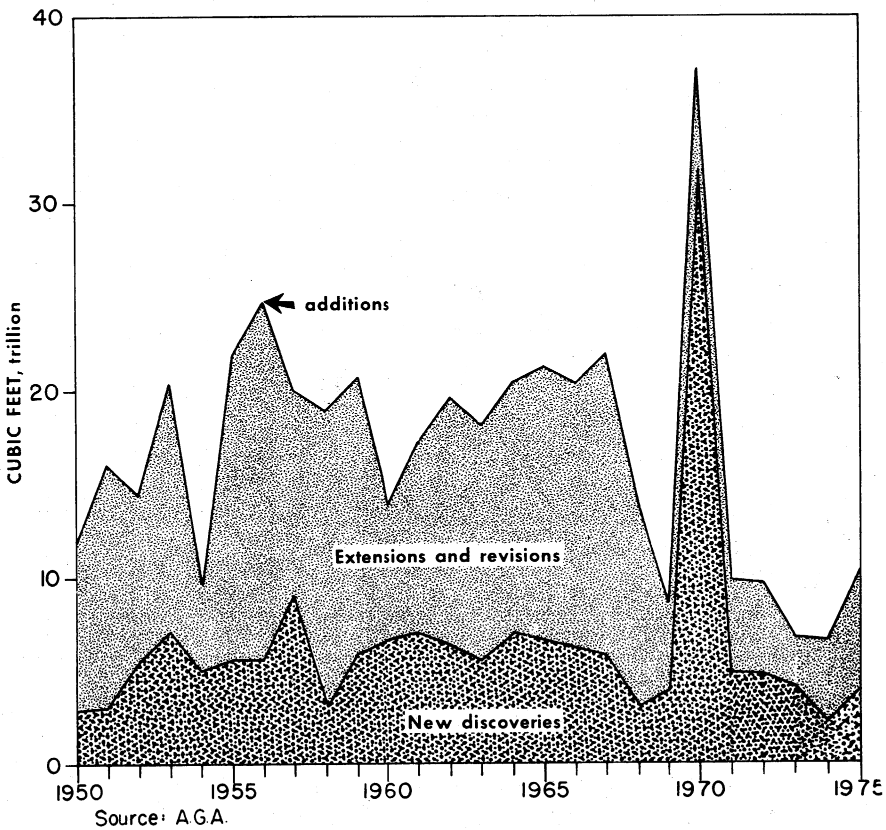

Figure 2.—Trends in annual additions to natural gas reserves.

STORAGE

The development of additional underground storage capacity for natural gas continued during 1975. Total reservoir capacity increased 4.4% from 6,364 Bcf in 1974 to 6,644 Bcf by yearend 1975. The number of underground storage facilities increased from 367 in 1974 to 376 in 1975. These storage facilities were located in 26 States.

Most storage reservoirs are depleted fields. Of the 376 storage reservoirs in use, 319 or nearly 85% were of this type. Most of these reservoirs are located in the northeastern United States, primarily in the oldest oil- and gas-producing provinces. In Pennsylvania, where oil production dates back to 1859, depleted fields converted to storage facilities totaled 68 at yearend 1975. West Virginia had 38 reservoirs of this type as of the same date. The second largest concentration of storage reservoirs was in the Midwest, primarily in Michigan where 37 were in use.

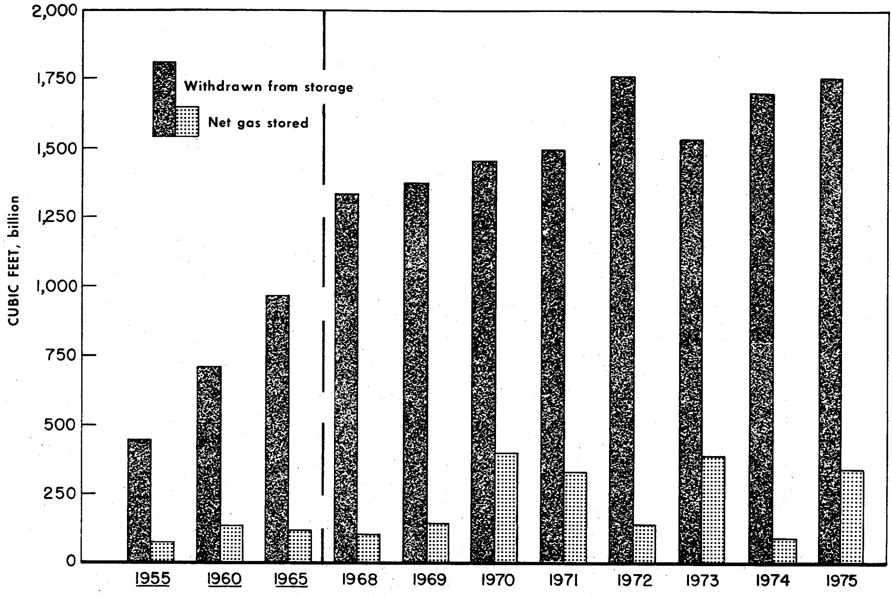

Figure 3.—Trends in net gas stored underground in U.S. storage fields.

Where depleted oil or gas fields are not available, other types of underground storage reservoirs have been developed (table 16). For example, 52 aquifer-type reservoirs were in use in 10 States at the end of 1975. Illinois was the leading State with 22, and Indiana ranked second with 10. Aquifer storage accounted for 22% of total underground storage capacity at yearend 1975. The increase in aquifer reservoir capacity during the year was negligible.

The development of underground storage reservoirs has been an important factor in meeting peak natural gas demand, particularly in the residential house-heating market, in which there is a high degree of seasonal variation. There is a concentration of underground storage facilities relatively close to the largest markets for residential heating. Illinois had 675 Bcf of natural gas stored in 31 reservoirs, and Pennsylvania had 608 Bcf stored in 68 reservoirs at the end of 1975. The two States accounted for 30% of the total stored gas in underground reservoirs.

In 1975, the total amount of gas moved into underground storage totaled 2,104 Bcf (table 17). During the same period, 1,760 Bcf was withdrawn, leaving a net stored of 344 Bcf for the year.

In addition to underground storage, there has been a marked growth in the aboveground storage of natural gas that has been liquefied by reducing its temperature to —258° F (—161° C). LNG occupies only 1/620th the space necessary for conventional vapor storage. LNG storage is used for peak-shaving purposes during the high-consumption low-temperature winter months.

The following tabulation summarizes LNG storage data:

Facility	Status	Capacity (Bcf)	Number of plants
Peak-shaving	Operational	49.7	51
Do	Under construction	9.4	8
Large satellite	Operational	5.2	20
Do	Under construction	2.5	3
Small satellite	Operational	.2	31
Import-receiving terminals	Do	11.2	3
Do	Under construction	9.0	2
Total	Operational	66.3	105
Total	Under construction	20.9	13

VALUE AND PRICE

Total wellhead value of marketed natural gas production increased 36.1% to $8,945 million in 1975, despite a 6.9% decline in production volume (table 18). This occurred as a result of a 46.4% increase in average wellhead value to 44.5 cents per Mcf. Texas and Louisiana accounted for 56.7% and 26.1%, respectively, of the $2,372 million increase in total value during 1975.

Wholesale Prices.—Average wholesale prices for natural gas in the 14 large metropolitan areas for which FPC collects such data rose substantially between July 1, 1974, and July 1, 1975. Increases for individual areas ranged from 15.7% to 92.3%, and the median price rise was 30.8%. Wholesale prices as of July 1, 1975, ranged from 67.93 cents per Mcf in the Minneapolis-St. Paul area to 133.14 cents per Mcf in the Boston area.

A 7-year historical series of average wholesale natural gas prices in the 14 large metropolitan areas is shown in table 19. The wholesale prices for gas in those cities cited are based on the effective FPC gas tariffs. In cities served by more than one pipeline, prices are based on weighted-average charges. Prices reflect deliveries at the city gate except for Los Angeles and San Francisco, where distributors purchase gas at the California-Oregon and California-Arizona State lines.

Retail Prices.—The average retail price for natural gas delivered to all classes of consumers increased 33.4% from 89.4 cents per Mcf in 1974 to 119.3 cents per Mcf in 1975. Monthly data, collected by the Bureau of Labor Statistics on the average price of residential heating gas for 20 standard metropolitan areas, indicate an average increase of 40.9% between January 1975 and January 1976. Increases for individual areas during the same period ranged from only 5.0% in Buffalo to 65.4% in Dallas and 48.7% in Houston, where much of the current supply is obtained under relatively recent, high-priced intrastate contracts. A historical summary of average residential heating gas prices in 20 standard metropolitan statistical areas appears in table 20.

FOREIGN TRADE

Exports of natural gas totaled 73 Bcf in 1975, a decline of 5.4% from 1974. Of the total 1975 volume, 72.9% was shipped from Port Nikiski, Alaska, to Japan as LNG. Exports via pipeline to Canada and Mexico were almost equally divided, with Canada receiving 51.9% of the total deliveries.

The LNG exported to Japan in 1975 totaled 53.0 Bcf valued at $73 million, compared with 50.3 Bcf valued at $37 million in 1974. The Alaskan LNG was exported rather than shipped to the lower 48 States since no receiving terminals exist on the U.S. west coast and there are no U.S. flag LNG tankers capable of transporting LNG from Alaska to the east coast. Federal Maritime law requires U.S. flag ships for all interstate seaborne trade. Statistics on LNG exports for 1975 are shown in table 21.

Exports via pipeline to Canada in 1975

totaled 10.2 Bcf, compared with 13.3 Bcf in 1974, a decline of 22.9% (table 22). Detroit was the exit point for most of these exports. Natural gas exports via pipeline to Mexico continued to decline from 13.3 Bcf in 1974 to 9.5 Bcf in 1975.

Pipeline imports of natural gas from Canada declined in 1975 to 948 Bcf, a decrease of 1.1% from those of 1974. These imports were valued at $1,147 million, more than double the 1974 total of $531 million. The rapid increase in value is reflected in the average price of gas from 55.35 cents per Mcf in 1974 to 121.03 per Mcf in 1975. Nine companies imported Canadian gas in 1975. For the first time since 1955 there were no imports of natural gas from Mexico.

Algeria, the only source of LNG imports during 1975, shipped a total of 4.9 Bcf valued at $3.6 million to Everett, Mass., the U.S. receiving point. There were no LNG imports from Canada in 1975.

The El Paso Natural Gas Co.'s 25-year contract with Société Nationale pour la Recherche, la Production, le Transport, la Transformation et la Commercialisation des Hydrocarbures (SONATRACH), the Algerian National Oil and Gas Company, which has been approved by FPC, calls for the delivery of LNG, equivalent to 1 Bcf per day. A fleet of nine tankers owned and operated by a subsidiary of El Paso will transport the LNG from Algeria to receiving terminals under construction at Cove Point, Md. and Elba Island, Ga.

The LNG receiving terminal under construction at Cove Point, Md., which is jointly owned by Columbia Gas System and Consolidated Natural Gas System, was about 50% complete at yearend 1975. Deliveries of LNG from El Paso Natural Gas Co. are expected to begin in late 1977. Initially, the terminal, with four storage tanks, will handle 650 MMcf (million cubic feet) of gas per day with 300 MMcf per day going to Columbia, and Consolidated receiving 350 MMcf per day. An area has been set aside for two more tanks when additional storage will be needed for future requirements. After being regassified at Cove Point, the gas will be shipped via an 87-mile pipeline being laid to a compressor station on Columbia's gas transmission system at Loudoun, Va.

Construction on the LNG receiving terminal on Elba Island near Savannah, Ga., owned by Southern Energy Co., was about one-third complete at yearend 1975, and is scheduled for completion in 1977. Southern will receive 350 MMcf of gas per day from El Paso.

Other proposed LNG projects are awaiting FPC approval.

WORLD REVIEW

World marketed production of natural gas continued to increase during 1975 when it totaled 47.2 Tcf (table 25). The United States accounted for 20.1 Tcf, or 42.6% of this total.

Algeria.—Marketed production in Algeria totaled 210 Bcf in 1975, an increase of 5.8% compared with that of 1974. Nearly all marketed natural gas production was exported as LNG.

Algeria's state-owned company SONATRACH cancelled a contract in November 1975 with Chemical Construction Corp. in a performance dispute over construction of the Arzew No. 1 gas liquefaction plant. Bechtel International, Inc., was named to complete the project. SONATRACH expects deliveries of LNG from this plant, which will be exported to the United States.

Algeria, Spain, and France jointly established the Segamo Co. to make economic feasibility studies on a proposed trans-Mediterranean pipeline to deliver gas from Algeria's Hassi R'Mel field to Western Europe.

Canada.—Marketed production in Canada, which ranked fourth in total output, totaled 3.1 Tcf in 1975, an increase of only 1% over that of 1974. More than 85% of total Canadian production came from the Province of Alberta, with British Columbia accounting for most of the remainder. Exports to the United States totaled 948 Bcf, about 30.8% of total production.

Canada's total proved gas reserves of 57 Tcf at yearend 1975 remained about the same as in 1974. Exploration in the Canadian Arctic continued to decline. This was due in part to the uncertainty of Government energy policies and extremely high operating costs.

In 1975, Sun Oil Co., Ltd., drilled a gas discovery well on Garry Island, just off the Mackenzie Delta. Tests yielded gas flows at rates up to 17 MMcf per day.

Commercial development is planned for three fields in the Mackenzie Delta area, Imperial Taglu, Gulf-Mobil Parsons, and Shell Niglintgak. Gulf Oil Canada, Ltd., has awarded a contract for engineering and design, to include a gathering system, support facilities, and a 300-MMcf-per-day gas-processing plant at the Parsons Lake field. Shell Canada, Ltd., plans a 150-MMcf-per-day processing plant at Niglintgak.

Applications from two separate consortia for the right to construct pipeline facilities that would transport Mackenzie Delta gas to market were before the National Energy Board at yearend 1975. Canadian Arctic Gas Pipeline, Ltd., a consortium of U.S. and Canadian companies, was seeking permission to construct a pipeline that would transport both Mackenzie Delta and northern Alaska gas. Foothills Pipe Lines, Ltd., a partnership between Alberta Gas Trunk Line Co., Ltd., and Westcoast Transmission Co., Ltd., was advocating the construction of a line (Maple Leaf Pipeline) that would transport only Canadian natural gas from the Mackenzie Delta.

There have been seven significant gas discoveries to date in the Arctic Islands with estimated reserves totaling 15 Tcf. Drake Point and Hecla, the two largest discoveries, are located on the Sabine Peninsula of Melville Island. The remaining five are clustered in the Ellef Ringnes Island area.

During 1975 the Polar Gas Project, under the management of TransCanada Pipelines, Ltd., continued to conduct research on the construction of a natural gas pipeline from the Canadian Arctic to southern Canada. Studies indicate a transmission system is technologically feasible. Investigation was expected to continue throughout 1976.

Netherlands.—The Netherlands, Western Europe's largest natural gas producer and exporter, displaced Canada as the world's third ranking natural gas producing country during 1975. Marketed production totaled 3.2 Tcf an increase of 8.5% over that of 1974, with the onshore Groningen field producing the largest share.

Offshore exploration and development in the Netherlands was increased during 1975, partly because of the Government's decision to acquire a 40% interest in these operations. The first gas deliveries from the North Sea began in mid-1975 upon completion of a 110-mile, 36-inch pipeline. Initially, 100 MMcf per day was brought ashore but this was expected to climb rapidly, with annual production expected to reach 70 Bcf in 1976. Half of the gas will go to West Germany under a 24-year contract.

In an effort to slow down the growth of energy consumption, the Netherlands Government has approved plans to gradually phase out gas sales to electric power stations and large factories after 1978. Priority will be given to small consumers. Exports will start to decline after 1978 and will virtually cease after 1994 because no new export contracts will be granted.

Norway.—Most of Norway's proved reserves at yearend 1975 were in the offshore Ekofisk and Frigg oil and gas fields. Deliveries of natural gas through a 274-mile pipeline from the Ekofisk field to Emden, West Germany, were scheduled to begin in the last half of 1976. Development of the giant Frigg gasfield in the North Sea was expected to be delayed at least 2 years because efforts were abandoned to salvage a $50 million drilling platform jacket that sank during installation.

Romania.—The 1975 marketed production in Romania was estimated at 954 Bcf, a decrease of 5.7% from that of 1974. Most of the gas produced was used domestically. Although exploration and development drilling continued in the Ploiesti-Focsani oil and gas district, indications were that future exploration would be concentrated in the Black Sea area. An agreement was signed with Italy's State-owned Ente Nazionale Idrocarburi (ENI) for future joint exploration in the Black Sea.

United Kingdom.—North Sea oil and gas activity was at the higest level in its 12-year history during 1975. Although more exploration programs were in progress than at any other time, by mid-1975 emphasis was turning toward development and production. Brent oil and gas field, the largest in the United Kingdom's waters, with gas reserves of 3 Tcf, and 2,000 million barrels of oil, was expected to be the world's most northerly producing offshore field in the open sea when production was scheduled to begin in 1976. In June 1975, British Gas Corp. signed a 20-year contract for natural gas from Brent field. The gas will flow at a minimum of 500 MMcf per day from a 300-mile 36-inch pipeline to St. Fergus, Scotland. Deliveries are expected to begin in 1980. The southern North Sea supplies about 30% of the total gas consumed in the United Kingdom.

U.S.S.R.—The U.S.S.R. was second to the United States accounting for 21.6% of world production Its 1975 marketed production was estimated to have been 10.2 Tcf, an increase of 10.9% over that of 1974. Exports of natural gas, mostly to Eastern European countries, climbed to a record high of more than 600 Bcf in 1975, compared with 496 Bcf in 1974.

An agreement was signed in 1975 with Iran involving the exportation of Iranian natural gas to Western Europe by means of an exchange arrangement. Iran will export 473 Bcf per year for consumption in the industrial centers of southwestern U.S.S.R. under terms of the agreement. The U.S.S.R. in turn, will pipe Siberian gas to Iran's West European customers—West Germany, France, and Austria. Deliveries are scheduled to begin in 1981 and continue for 20 years.

Natural gas production in western Siberia climbed to 1.3 Tcf in 1975, with the Medvezhye field in Tyumen Province accounting for about 88% of this total. Urengoiskoye, the U.S.S.R.'s largest gasfield, with estimated reserves of 178 Tcf, located 60 miles east of Medvezhye, is scheduled for production in 1977. Most of the U.S.S.R.'s gas reserves are located in western Siberia, near or above the Arctic Circle.

TECHNOLOGY

The shortage of natural gas continued to stimulate Government and industry research in coal gasification. Three pilot projects for development and testing of processes for the production of high-Btu gas from coal were operational, and three others were under construction at yearend 1975. A pilot project involving the production of low-Btu gas from coal was also operational, and two others were under construction as of the same date. During the latter part of 1975, the Energy Research and Development Administration (ERDA) was in the process of preparing invitations for proposals covering the design, construction, and operation of high-Btu and low-Btu coal gasification demonstration plants. These facilities would provide the final development step prior to the construction of a commercial plant.

The Bureau of Mines continued its experiment in gathering methane from a coal deposit near Bula, W. Va. This project drained approximately 220 MMcf from a coalbed through a large air shaft during 1975. Some of the drained methane was sold to Consolidated Gas Supply Corp. for delivery to a nearby community. This experiment was being carried out with a dual purpose. To provide additional natural gas supplies for distribution; and to reduce coal mining hazards.

Efforts to supplement natural gas supplies through the gasification of naphtha and natural gas liquids continued. As of yearend 1975, a total of 11 such synthetic gas plants were operational, 2 were under construction, and 2 were in the planning stage.

Other gasification projects in progress involved biomass conversion. During 1975, Los Angeles County began the recovery of methane from the Palos Verdes sanitary landfill in cooperation with NRG NuFuel Inc. and Reserve Oil & Gas Co. This project is expected to yield 2 Bcf of pipeline-quality gas annually. In addition, projects for the production of pipeline-quality gas from animal waste by the process of anaerobic digestion were in various stages of development in Colorado, Oklahoma, and Texas.

In addition, to gasification projects, research has also focused on fracturing techniques that stimulate flow from economically submarginal gas reservoirs. Most of this activity was in Wyoming, Colorado, and Utah, but one major project initiated during 1975 involved the massive hydraulic fracturing of Upper Devonian gas shales in Mingo County, W. Va. These shales underlie about 12 Eastern States, including those that comprise the major northeastern markets, and are estimated to contain producible gas that may exceed the Nation's total current proved reserves. The U.S. Geological Survey is to provide coordination and assistance in the resource assessment activities of the program.

During 1975, the U.S. Geological Survey studied the methane-saturated Gulf coast salt water aquifers penetrated by 193 wells in Texas and Louisiana. On the basis of this study, the Survey estimated that these aquifers in onshore reservoirs alone may contain up to 24,000 Tcf of methane.

Table 2.—Gas pipeline failures reported during 1974–75

System and cause of failure	Total number of failures		Fatalities				Injuries			
			Employees		Non-employees		Employees		Non-employees	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Distribution:										
Corrosion	108	94	--	--	3	1	3	6	27	23
Damage by outside forces	756	744	1	--	16	5	13	7	203	119
Construction defect or material failure	94	78	--	--	--	--	4	1	28	25
Other causes	59	63	--	--	--	2	11	15	25	24
Total	1,017	979	1	--	19	8	31	29	283	191
Transmission and gathering:										
Corrosion	78	44	--	3	--	1	--	2	4	4
Damage by outside forces	274	237	--	--	--	--	1	--	8	5
Construction defect or material failure	81	88	--	1	3	--	--	5	--	--
Other causes	27	25	1	1	--	--	6	1	1	--
Total	460	394	1	5	3	1	7	8	13	9
Grand total	1,477	1,373	2	5	22	9	38	37	296	200

Source: Office of Pipeline Safety, Department of Transportation.

Table 3.—Gross withdrawals and disposition of natural gas in the United States
(Million cubic feet at 14.73 psia)

State	Gross withdrawals			Disposition		
	From gas wells	From oil wells	Total [1]	Marketed production	Repressuring	Vented and flared [2]
1974						
Alabama	23,970	5,387	29,357	27,865	--	1,492
Alaska	125,349	104,614	229,963	128,935	89,504	11,524
Arizona	27	223	250	224	--	26
Arkansas	92,265	33,426	125,691	123,975	--	1,716
California	222,673	204,301	426,974	365,354	60,060	1,560
Colorado	108,962	38,890	147,852	144,629	266	2,957
Florida	--	38,137	38,137	38,137	--	--
Illinois	1,436	(3)	1,436	1,436	--	--
Indiana	176	(3)	176	176	--	--
Kansas	747,580	141,870	889,450	886,782	1,779	889
Kentucky	71,876	--	71,876	71,876	--	--
Louisiana	7,037,239	882,571	7,919,810	7,753,631	134,607	31,572
Maryland	133	--	133	133	--	--
Michigan	45,745	24,719	70,464	69,133	63	1,268
Mississippi	76,295	22,700	98,995	78,787	9,421	10,787
Missouri	33	(3)	33	33	--	--
Montana	51,644	7,880	59,524	54,873	750	3,901
Nebraska	2,194	2,481	4,675	2,538	--	2,137
New Mexico	944,515	309,784	1,254,299	1,244,779	8,293	1,227
New York	4,990	(3)	4,990	4,990	--	--
North Dakota	287	48,779	49,066	31,206	--	17,860
Ohio	77,114	16,749	93,863	92,055	1,808	--
Oklahoma	1,425,283	331,346	1,756,629	1,638,942	83,488	34,199
Pennsylvania	82,735	(3)	82,735	82,637	--	98
South Dakota	48	--	48	--	48	--
Tennessee	17	376	393	17	--	376
Texas	7,029,873	1,829,171	8,859,044	8,170,798	653,815	34,431
Utah	21,433	58,540	79,973	50,522	24,192	5,259
Virginia	7,096	--	7,096	7,096	--	--
West Virginia	202,306	(3)	202,306	202,306	--	--
Wyoming	265,918	78,637	344,555	326,657	11,796	6,102
Total	18,669,212	4,180,581	22,849,793	21,600,522	1,079,890	169,381
1975						
Alabama	33,660	5,261	38,921	37,814	--	1,107
Alaska	138,153	115,074	253,227	160,270	82,556	10,401
Arizona	4	251	255	208	--	47
Arkansas	91,270	30,248	121,518	116,237	3,963	1,318
California	173,499	194,154	367,653	318,308	47,808	1,537
Colorado	130,743	43,402	174,145	171,629	--	2,516
Florida	--	44,383	44,383	44,383	--	--
Illinois	1,440	(3)	1,440	1,440	--	--
Indiana	346	(3)	346	346	--	--
Kansas	705,746	140,418	846,164	843,625	1,693	846
Kentucky	60,511	(3)	60,511	60,511	--	--
Louisiana	6,455,690	786,718	7,242,408	7,090,645	126,304	25,459
Maryland	93	--	93	93	--	--
Michigan	71,907	31,994	103,901	102,113	176	1,612
Mississippi	74,367	18,133	92,500	74,345	6,293	11,862
Missouri	30	(3)	30	30	--	--
Montana	41,474	3,073	44,547	40,734	611	3,202
Nebraska	1,605	2,358	3,963	2,565	--	1,398
New Mexico	915,370	311,830	1,227,200	1,217,430	8,128	1,642
New York	7,628	(3)	7,628	7,628	--	--
North Dakota	287	26,654	26,941	24,786	--	2,155
Ohio	85,810	(3)	85,810	84,960	850	--
Oklahoma	1,412,637	308,061	1,720,698	1,605,410	83,486	31,802
Pennsylvania	84,772	(3)	84,772	84,676	--	96
South Dakota	39	(3)	39	--	35	4
Tennessee	27	585	612	27	--	585
Texas	6,463,095	1,525,678	7,988,773	7,485,764	471,714	31,295
Utah	19,001	58,606	77,607	55,354	20,447	1,806
Virginia	6,723	--	6,723	6,723	--	--
West Virginia	154,484	(3)	154,484	154,484	--	--
Wyoming	249,882	76,356	326,238	316,123	6,892	3,223
Total	17,380,293	3,723,237	21,103,530	20,108,661	860,956	133,913

[1] Marketed production plus quantities used in repressuring and vented and flared.
[2] Partly estimated; includes direct losses on producing properties and residue blown to the air.
[3] Not reported separately, included under "Gross Withdrawals From Gas Wells."

Source: Figures based on reports received from State agencies and Bureau of Mines estimates.

Table 4.—Gas and oil well completions in the United States, by State, 1970–75

State	Gas completions [1]						Oil completions [2]					
	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975
Alabama	5	6	9	10	16	26	7	8	13	18	16	20
Alaska	5	1	2	3	4	4	67	27	12	20	27	44
Arizona	--	2	1	1	--	--	1	--	5	--	3	--
Arkansas	36	29	39	40	41	23	100	127	96	91	99	147
California	56	60	62	65	69	46	1,697	1,459	1,045	879	1,567	1,854
Colorado	47	148	124	148	201	300	142	154	300	228	218	328
Florida	--	--	--	--	--	--	14	8	65	24	9	15
Illinois	5	16	18	13	11	5	311	252	255	240	357	460
Indiana	4	2	5	8	21	17	93	81	92	67	136	145
Kansas	108	112	368	384	389	438	1,044	1,099	880	592	989	1,094
Kentucky	111	135	166	157	127	123	275	244	230	158	195	304
Louisiana:												
North	157	237	451	269	458	413	263	390	291	234	326	402
South	232	200	234	284	190	220	497	398	375	337	283	373
Offshore	150	184	133	231	141	182	382	258	253	287	216	181
Total Louisiana	539	621	818	784	789	815	1,142	1,046	919	858	825	956
Michigan	19	33	34	41	52	33	49	81	87	73	116	169
Mississippi	12	13	13	28	26	31	211	175	87	70	67	83
Missouri	--	1	--	--	2	1	10	6	--	--	7	6
Montana	74	33	125	123	145	279	64	45	83	46	60	100
Nebraska	2	1	2	--	5	1	39	47	48	33	40	74
New Mexico	159	186	238	498	463	517	341	401	502	280	350	437
New York	17	7	22	27	98	236	69	83	96	97	153	142
North Dakota	1	1	--	--	--	--	48	49	23	40	42	69
Ohio	683	608	721	940	1,050	555	503	391	426	393	567	550
Oklahoma	321	238	341	539	744	638	1,343	1,174	1,025	898	1,149	1,743
Pennsylvania	250	199	297	434	468	640	441	394	534	525	671	691
South Dakota	--	--	--	--	--	--	--	2	4	5	1	5
Tennessee	4	23	9	10	12	38	24	57	14	24	61	46
Texas	774	810	943	1,475	1,843	2,135	4,137	3,880	3,963	3,686	4,402	6,074
Utah	10	6	13	25	12	19	29	30	73	104	118	110
Virginia	--	--	18	7	55	26	--	--	--	--	--	2
West Virginia	553	496	488	514	556	556	192	133	84	72	121	120
Wyoming	45	43	52	61	40	78	627	405	345	381	418	620
Grand total	3,840	3,830	4,928	6,335	7,239	7,580	13,020	11,858	11,306	9,902	12,784	16,408

[1] Includes multiple completion wells that produce gas from all zones.
[2] Includes multiple completion wells that produce gas from one or more zones but oil from at least one zone.

Source: American Petroleum Institute Quarterly Review of Drilling Statistics for the United States, Annual Summaries 1970 to 1975, inclusive.

Table 5.—Exploratory wells drilled in the United States, by State, 1970–75

State	Gas completions [1]						Oil completions [2]					
	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975
Alabama	1	2	6	5	4	8	2	3	2	4	5	4
Alaska	1	--	1	1	3	3	23	1	--	2	2	6
Arizona	--	1	1	1	--	--	--	--	--	--	--	--
Arkansas	4	2	1	2	2	1	7	9	7	4	8	9
California	8	5	9	17	16	17	28	21	17	17	28	36
Colorado	15	27	29	29	26	19	26	29	71	38	25	37
Florida	--	--	--	--	--	--	2	--	2	3	2	--
Illinois	2	4	2	1	3	--	16	24	20	22	25	29
Indiana	3	1	3	3	6	5	8	14	11	11	18	15
Kansas	--	14	26	40	33	37	131	131	117	98	98	115
Kentucky	26	12	18	16	20	21	21	23	30	18	24	58
Louisiana	69	72	79	54	61	82	40	43	24	22	24	30
Michigan	7	13	21	31	34	17	9	26	34	38	50	55
Mississippi	2	3	4	15	6	5	25	13	9	13	23	23
Missouri	--	--	--	--	1	1	--	--	--	--	--	--
Montana	20	16	29	28	35	44	21	4	15	10	10	14
Nebraska	--	--	--	--	3	1	10	7	10	7	13	17
New Mexico	8	7	27	25	48	36	16	6	14	9	8	26
New York	2	3	3	3	19	9	--	--	1	2	--	1
North Dakota	--	--	--	--	--	--	7	8	7	4	11	14
Ohio	17	7	24	31	117	87	1	--	2	--	20	10
Oklahoma	43	27	55	69	61	52	59	42	37	35	51	59
Pennsylvania	21	3	20	41	42	46	2	1	3	3	11	11
South Dakota	--	--	--	--	--	--	--	2	--	4	--	4
Tennessee	1	14	7	8	11	30	5	16	4	6	17	13
Texas	179	172	183	410	562	571	256	186	179	207	278	311
Utah	4	4	2	13	4	6	9	8	22	4	4	7
Virginia	--	--	--	2	5	2	--	--	--	--	--	2
West Virginia	31	18	35	39	53	42	--	1	1	4	5	3
Wyoming	7	10	16	16	19	29	66	33	45	34	54	63
Total	471	437	601	900	1,194	1,171	790	651	684	619	814	972

[1] Includes multiple completion wells that produce gas from all zones.
[2] Includes multiple completion wells that produce gas from one or more zones but oil from at least one zone.

Source: American Petroleum Institute Quarterly Review of Drilling Statistics for the United States, Annual Summaries 1970 to 1975, inclusive.

Table 6.—Producing gas and condensate wells in the United States[1]

PAD district and State	Dec. 31, 1970	Dec. 31, 1971	Dec. 31, 1972	Dec. 31, 1973	Dec. 31, 1974	Dec. 31, 1975
District 1:						
Maryland	16	14	16	15	15	15
New York	600	600	650	789	700	900
Pennsylvania	16,239	16,586	16,600	16,600	17,123	17,500
Virginia	115	115	130	178	174	186
West Virginia	20,702	21,025	21,324	21,400	21,450	21,700
Total	37,672	38,340	38,720	38,982	39,462	40,301
District 2:						
Illinois	8	14	31	36	37	41
Indiana	50	83	87	106	474	478
Kansas	8,660	8,585	8,621	8,785	8,800	8,865
Kentucky	6,913	7,413	7,099	7,224	7,307	7,386
Michigan	1,235	1,171	1,317	1,145	503	209
Missouri	11	2	3	2	3	3
Nebraska	35	29	29	29	25	19
North Dakota	29	29	21	44	34	18
Ohio	7,789	8,179	8,630	9,406	10,038	10,382
Oklahoma	8,168	8,507	8,457	8,868	9,401	9,769
South Dakota	--	--	r 5	r 10	r 20	20
Tennessee	15	20	45	6	13	5
Total	32,913	34,032	r 34,345	r 35,661	r 36,655	37,195
District 3:						
Alabama	2	--	15	15	6	9
Arkansas	1,008	1,013	1,041	876	1,172	1,128
Louisiana	9,690	9,748	9,456	10,551	9,248	9,182
Mississippi	325	400	252	250	239	248
New Mexico	8,848	9,388	9,679	9,711	9,915	10,352
Texas	23,417	23,280	23,373	23,805	24,646	26,184
Total	43,290	43,829	43,816	45,208	45,226	47,103
District 4:						
Colorado	861	928	934	1,050	1,347	1,662
Montana	739	1,056	1,116	1,118	1,450	1,235
Utah	173	178	200	158	114	271
Wyoming	800	840	887	850	900	950
Total	2,573	3,002	3,137	3,176	3,811	4,118
District 5:						
Alaska	51	40	50	52	52	61
Arizona	4	5	4	4	1	1
California	980	962	1,086	1,095	1,142	1,585
Total	1,035	1,007	1,140	1,151	1,195	1,647
Total United States	117,483	120,210	r 121,158	r 124,178	r 126,349	130,364

r Revised.
[1] Based on State reports, State estimates, and World Oil magazine.

Table 7.—Consumption of natural gas by use and by State, 1975

Region and State	Delivered to consumers		Extraction loss		Lease and plant fuel		Pipeline fuel		Total	
	Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)	Value (thousands)
New England:										
Connecticut	63,968	$183,556	--	--	--	--	43	$25	64,011	$183,581
Maine, New Hampshire, Vermont	13,534	28,380	--	--	--	--	--	--	13,534	28,380
Massachusetts	153,461	441,186	--	--	--	--	506	213	153,967	441,399
Rhode Island	23,107	64,267	--	--	--	--	22	12	23,129	64,279
Total	254,070	717,389	--	--	--	--	571	250	254,641	717,639
Middle Atlantic:										
New Jersey	243,714	569,988	--	--	--	--	388	129	244,102	570,117
New York	573,699	1,256,577	--	--	267	$206	2,917	1,132	576,883	1,257,915
Pennsylvania	634,285	984,562	68	$50	1,760	1,292	17,697	9,503	653,810	995,407
Total	1,451,698	2,811,127	68	50	2,027	1,498	21,002	10,764	1,474,795	2,823,439
East North Central:										
Illinois	1,080,787	1,525,569	12,785	6,047	102	40	14,226	7,696	1,107,900	1,539,352
Indiana	467,736	535,185	--	--	--	--	9,605	7,669	477,341	538,854
Michigan	865,539	1,252,722	2,879	1,278	8,420	4,404	10,225	5,767	887,063	1,264,171
Ohio	944,925	1,258,518	--	--	2,925	2,097	9,026	3,917	956,876	1,264,532
Wisconsin	359,844	475,308	--	--	--	--	4,957	2,191	364,801	477,499
Total	3,718,831	5,047,302	15,664	7,325	11,447	6,541	48,039	23,240	3,793,981	5,084,408
West North Central:										
Iowa	329,703	332,647	--	--	--	--	16,095	5,424	345,798	338,071
Kansas	402,273	267,626	42,763	19,115	27,212	14,531	69,242	22,850	541,490	324,122
Minnesota	327,315	380,126	--	--	--	--	3,871	2,141	331,186	382,267
Missouri	362,130	423,720	--	--	--	--	7,490	2,929	369,620	426,649
Nebraska	207,371	185,069	313	150	1,036	408	10,427	3,378	219,147	189,005
North Dakota	24,757	31,218	2,404	1,019	12,008	3,819	61	31	39,230	36,087
South Dakota	32,502	33,679	--	--	--	--	32	16	32,534	33,695
Total	1,686,051	1,654,085	45,480	20,284	40,256	18,758	107,218	36,769	1,879,005	1,729,896
South Atlantic:										
Delaware	18,603	34,653	--	--	--	--	--	--	18,603	34,653
Florida	271,471	260,019	9,170	5,053	6,304	4,013	2,320	842	289,265	269,927
Georgia	322,383	333,749	--	--	--	--	4,176	1,336	326,559	335,085
Maryland and District of Columbia	163,462	326,197	--	--	277	490	2,193	838	165,932	327,525
North Carolina	111,276	178,033	--	--	--	--	3,546	1,089	114,822	179,122

South Carolina	120,308	143,823	--	--	--	--	2,641	1,294	122,949	145,117
Virginia	118,083	205,481	--	--	168	97	3,069	1,154	121,320	206,732
West Virginia	142,585	172,003	9,258	3,666	1,791	915	14,059	8,309	167,693	184,893
Total	1,268,171	1,653,958	18,428	8,719	8,540	5,515	32,004	14,862	1,327,143	1,683,054
East South Central:										
Alabama	245,287	238,939	694	466	1,968	1,356	16,833	5,403	264,782	246,164
Kentucky	182,781	187,037	5,454	1,985	1,218	436	23,540	8,710	212,993	198,168
Mississippi	183,807	158,130	567	220	7,894	3,300	38,352	13,615	230,620	175,265
Tennessee	197,789	188,265	--	--	387	197	19,152	6,990	217,328	195,452
Total	809,664	772,371	6,715	2,671	11,467	5,289	97,877	34,718	925,723	815,049
West South Central:										
Arkansas	241,803	191,325	899	376	4,200	1,348	12,217	5,241	259,119	198,290
Louisiana	1,425,686	1,066,189	189,541	127,561	301,816	98,694	61,086	23,701	1,978,129	1,316,145
Oklahoma	565,387	396,783	60,008	24,303	79,728	24,556	23,704	6,495	728,827	452,137
Texas	3,099,149	2,969,780	435,571	265,698	763,107	421,235	82,121	30,221	4,379,948	3,686,934
Total	5,332,025	4,624,077	686,019	417,938	1,148,851	545,833	179,128	65,658	7,346,023	5,653,506
Mountain:										
Arizona	139,130	148,273	--	--	--	--	17,092	6,068	156,222	154,341
Colorado	294,760	265,090	9,620	6,311	7,673	4,450	5,339	2,621	317,392	278,472
Idaho	56,182	84,598	--	--	38	26	4,231	2,522	60,451	87,146
Montana	75,441	82,188	831	446	2,315	713	1,764	734	80,351	84,081
Nevada	61,251	87,363	--	--	--	--	--	--	61,251	87,363
New Mexico	172,638	125,476	56,109	23,173	38,604	13,125	29,018	11,172	296,369	172,946
Utah	116,620	117,028	3,659	2,294	7,240	3,034	300	161	127,819	122,517
Wyoming	66,818	42,480	13,224	5,819	15,102	4,561	5,268	2,713	100,412	55,573
Total	982,840	952,496	83,443	38,043	70,972	25,909	63,012	25,991	1,200,267	1,042,439
Pacific:										
Alaska	66,815	59,191	1,244	493	17,842	5,995	94	33	85,995	65,712
California	1,727,729	2,254,494	15,221	11,583	84,843	44,543	20,277	9,571	1,858,070	2,320,191
Oregon	101,980	147,846	--	--	32	22	7,886	4,826	109,898	152,694
Washington	158,479	260,141	--	--	--	--	5,855	3,788	164,334	263,929
Total	2,055,003	2,721,672	16,465	12,076	102,717	50,560	34,112	18,218	2,208,297	2,802,526
Total United States	17,558,353	20,954,477	872,282	507,106	1,396,277	659,903	582,963	230,470	20,409,875	22,351,956

NOTE.—All quantities at pressure base of 14.73 psia.

Table 8.—Quantity and value of natural gas delivered

Region and State	Residential: Quantity (million cubic feet)	Residential: Value (thousands)	Residential: Number of consumers (thousands)	Commercial: Quantity (million cubic feet)	Commercial: Value (thousands)	Commercial: Number of consumers (thousands)
New England:						
Connecticut	32,143	$105,846	373	15,383	$41,088	29
Maine, Vermont, New Hampshire	5,578	14,773	66	3,621	7,768	6
Massachusetts	90,226	284,392	1,033	33,819	89,654	68
Rhode Island	13,043	40,238	154	4,129	11,446	10
Total	140,990	445,249	1,626	56,952	149,956	113
Middle Atlantic:						
New Jersey	129,406	348,361	1,624	52,147	121,867	179
New York	327,384	830,246	3,810	117,012	238,938	238
Pennsylvania	272,634	527,274	2,160	92,911	159,621	147
Total	729,424	1,705,881	7,594	262,070	520,426	564
East North Central:						
Illinois	478,602	771,985	2,911	214,028	281,661	224
Indiana	162,858	236,958	1,087	68,545	85,887	99
Michigan	334,866	542,818	2,068	177,218	263,700	166
Ohio	427,817	643,437	2,559	163,976	220,384	198
Wisconsin	119,981	209,487	868	61,866	83,767	74
Total	1,524,124	2,404,685	9,493	685,633	935,399	761
West North Central:						
Iowa	94,370	134,665	623	62,724	68,432	75
Kansas	98,372	101,225	651	48,714	33,223	65
Minnesota	114,416	179,519	724	62,412	78,140	69
Missouri	155,178	231,991	1,085	77,692	93,075	88
Nebraska	53,803	68,922	356	40,999	40,712	56
North Dakota	10,200	15,392	65	12,371	13,645	9
South Dakota	11,969	16,721	83	11,227	11,205	11
Total	538,308	748,435	3,587	316,139	338,432	373
South Atlantic:						
Delaware	6,985	16,945	78	2,964	5,635	5
Florida	15,209	41,657	373	25,768	49,706	38
Georgia	87,184	130,514	846	45,152	50,074	66
Maryland and District of Columbia	82,380	192,088	854	32,836	67,513	64
North Carolina	27,466	55,591	306	18,144	31,534	43
South Carolina	18,211	38,789	259	15,115	19,861	26
Virginia	48,802	109,512	481	25,585	46,744	41
West Virginia	51,296	74,533	400	22,761	28,406	35
Total	337,533	659,629	3,597	188,325	299,473	318
East South Central:						
Alabama	52,314	82,028	603	32,153	34,822	43
Kentucky	79,156	97,124	585	33,512	36,092	56
Mississippi	29,530	41,578	347	15,204	15,888	36
Tennessee	44,020	56,830	432	38,569	45,010	57
Total	205,020	277,560	1,967	119,438	131,812	192
West South Central:						
Arkansas	48,543	54,174	411	32,676	29,310	52
Louisiana	96,221	131,630	914	27,427	27,811	66
Oklahoma	79,921	97,344	680	39,968	37,690	74
Texas	232,320	353,823	2,693	81,836	106,960	241
Total	457,005	636,971	4,698	181,907	201,771	433
Mountain:						
Arizona	37,931	58,186	526	29,494	34,773	45
Colorado	99,933	115,622	679	72,843	73,207	86
Idaho	14,089	30,728	119	11,493	18,320	17
Montana	24,097	31,230	159	16,233	17,872	21
Nevada	11,091	21,627	109	9,989	16,282	5
New Mexico	27,826	37,006	240	12,491	12,491	25
Utah	59,736	72,758	294	6,018	9,159	14
Wyoming	12,128	12,334	101	10,159	6,857	10
Total	286,831	379,491	2,227	168,720	188,961	223

See footnotes at end of table.

to consumers in 1975, by type of consumer and by State

Industrial [1]		Electric utilities		Other consumers [2]		Total	
Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet) [3]	Value (thousands)	Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)	Value (thousands)
15,553	$34,948	344	$469	545	$1,205	63,968	$183,556
3,330	4,853	732	505	273	481	13,534	28,380
23,986	54,976	1,437	1,746	3,993	10,418	153,461	441,186
5,820	12,391	11	14	104	178	23,107	64,267
48,689	107,168	2,524	2,734	4,915	12,282	254,070	717,389
52,361	88,961	8,601	8,455	1,199	2,344	243,714	569,988
104,429	156,017	13,613	13,572	11,261	17,804	573,699	1,256,577
261,447	286,807	1,213	1,333	6,080	9,527	634,285	984,562
418,237	531,785	23,427	23,360	18,540	29,675	1,451,698	2,811,127
352,291	430,852	34,176	39,542	1,690	1,529	1,080,787	1,525,569
223,383	201,491	10,994	8,993	1,956	1,856	467,736	535,185
301,573	378,173	47,151	61,956	4,731	6,075	865,539	1,252,722
341,612	379,531	6,139	7,968	5,381	7,198	944,925	1,258,518
152,443	160,522	19,935	16,745	5,619	4,787	359,844	475,308
1,371,302	1,550,569	118,395	135,204	19,377	21,445	3,718,831	5,047,302
121,489	94,640	46,929	32,240	4,191	2,670	329,703	332,647
124,378	67,164	127,818	64,548	2,991	1,466	402,273	267,626
100,539	84,051	22,709	12,376	27,239	26,040	327,315	380,126
89,913	72,110	26,320	14,950	13,027	11,594	362,130	423,720
72,792	49,863	37,659	23,424	2,118	2,148	207,371	185,069
1,975	1,979	157	102	54	100	24,757	31,218
5,813	3,499	3,232	2,046	261	208	32,502	33,679
516,899	373,306	264,824	149,686	49,881	44,226	1,686,051	1,654,085
6,957	9,684	1,697	2,389	--	--	18,603	34,653
83,364	85,531	141,153	78,905	5,977	4,220	271,471	260,019
145,479	122,639	40,282	26,425	4,286	4,097	322,383	333,749
43,165	59,222	451	459	4,630	6,915	163,462	326,197
62,094	84,634	101	93	3,471	6,181	111,276	178,033
70,329	72,298	14,566	11,187	2,087	1,688	120,308	143,823
36,427	40,070	496	350	6,773	8,805	118,083	205,481
66,155	67,015	358	227	2,015	1,822	142,585	172,003
513,970	541,093	199,104	120,035	29,239	33,728	1,268,171	1,653,958
153,540	114,541	5,994	6,456	1,286	1,092	245,287	238,939
64,856	48,837	272	248	4,985	4,736	182,781	187,037
98,848	71,269	31,507	22,717	8,718	6,678	183,807	158,130
111,281	83,572	--	--	3,919	2,853	197,789	188,265
428,525	318,219	37,773	29,421	18,908	15,359	809,664	772,371
128,151	86,117	31,818	21,382	615	342	241,803	191,325
922,673	702,154	356,130	191,954	23,235	12,640	1,425,686	1,066,189
142,812	102,396	300,848	157,945	1,838	1,408	565,387	396,783
1,396,790	1,322,760	1,353,290	1,170,596	34,913	15,641	3,099,149	2,969,780
2,590,426	2,213,427	2,042,086	1,541,877	60,601	30,031	5,332,025	4,624,077
50,868	38,507	17,693	13,747	3,144	3,060	139,130	148,273
65,609	42,318	52,930	31,652	3,445	2,291	294,760	265,090
29,898	35,011	18	11	684	528	56,182	84,598
31,631	30,018	1,059	516	2,421	2,552	75,441	82,188
10,043	11,389	25,152	31,188	4,976	6,877	61,251	87,363
57,773	35,877	64,239	34,432	10,309	5,670	172,638	125,476
48,104	33,336	2,725	1,739	37	36	116,620	117,028
43,618	22,594	819	650	94	45	66,818	42,480
337,544	249,050	164,635	113,935	25,110	21,059	982,840	952,496

Table 8.—Quantity and value of natural gas delivered to consumers

Region and State	Residential			Commercial		
	Quantity (million cubic feet)	Value (thousands)	Number of consumers (thousands)	Quantity (million cubic feet)	Value (thousands)	Number of consumers (thousands)
Pacific:						
Alaska	10,393	$16,909	25	8,475	$10,323	4
California	631,398	993,820	6,181	232,911	301,853	389
Oregon	28,749	63,133	232	15,896	29,614	30
Washington	34,349	78,110	289	31,662	57,878	38
Total	704,889	1,151,972	6,727	288,944	399,668	461
Total United States	4,924,124	8,409,873	41,516	2,268,128	3,165,898	3,438

[1] Includes refinery fuel use of 945,557 million cubic feet and 26,246 million cubic feet for carbon
[2] Includes deliveries to municipalities and public authorities for institutional heating, street
[3] Source: Federal Power Commission.

NOTE.—All quantities at pressure base of 14.73 psia.

in 1975, by type of consumer and by State—Continued

Industrial[1]		Electric utilities		Other consumers[2]		Total	
Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)[3]	Value (thousands)	Quantity (million cubic feet)	Value (thousands)	Quantity (million cubic feet)	Value (thousands)
22,388	$18,157	19,616	$10,084	5,940	$3,718	66,815	$59,191
581,609	646,168	274,483	304,951	7,328	7,702	1,727,729	2,254,494
57,332	55,096	3	3	--	--	101,980	147,846
92,142	123,839	--	--	326	314	158,479	260,141
753,471	843,260	294,105	315,038	13,594	11,734	2,055,003	2,721,672
6,979,063	6,727,877	3,146,873	2,431,290	240,165	219,539	17,558,353	20,954,477

black production.
lighting, etc.

Table 9.—Production of natural gas liquids at natural gas processing plants, and disposition of residual gas in the United States in 1974–75, by State

(Million cubic feet at 14.73 psia at 60° F. unless otherwise stated)

State	Total natural gas liquids and ethane production (thousand 42-gallon barrels)	Natural gas processed	Extraction loss (shrinkage)	Disposition of residue gas						
				Used at plants	Returned to formation	Vented and flared	Shipped to transmission companies	Direct deliveries to consumers	Unaccounted for	Total
1974:										
Arkansas	617	19,784	952	2,471	137	--	14,323	1,722	179	18,832
California	10,804	252,402	17,201	20,343	129,332	159	58,564	24,118	2,685	235,201
Colorado	4,154	118,686	6,210	4,612	4,949	437	100,748	1,364	366	112,476
Florida, Pennsylvania, West Virginia	8,810	409,248	13,049	4,720	8	--	391,108	363	--	396,199
Illinois and Kentucky	12,628	342,046	19,378	4,319	--	--	316,163	1,984	202	322,668
Kansas	31,032	1,407,239	43,416	10,165	1,742	159	1,301,549	50,149	59	1,363,823
Louisiana	144,299	6,273,136	194,329	103,973	102,858	1,510	5,169,920	704,324	—3,778	6,078,807
Michigan	1,315	45,106	1,921	1,713	1,994	38	39,708	--	—268	43,185
Mississippi and Alabama	784	24,568	1,180	1,638	3,070	67	13,899	4,532	182	23,388
Montana, Utah, Alaska	4,018	146,907	5,912	6,071	92,638	1,416	28,916	9,192	2,762	140,995
Nebraska, North Dakota, South Dakota	2,032	34,243	3,031	3,182	7,267	66	20,454	--	243	31,212
New Mexico	39,984	1,060,491	54,986	49,981	4,489	2,902	846,035	97,612	4,486	1,005,505
Oklahoma	43,812	1,092,487	62,860	51,138	72,012	897	823,053	77,391	5,136	1,029,627
Texas	302,072	7,194,453	448,993	289,419	721,678	9,219	4,962,687	709,383	53,074	6,745,460
Wyoming	9,737	263,684	14,072	9,497	8,997	391	224,561	6,478	—312	249,612
Total	616,098	18,684,480	887,490	563,242	1,151,171	17,261	14,311,688	1,688,612	65,016	17,796,990
1975:										
Arkansas	603	17,918	899	2,408	89	2	14,403	--	117	17,019
California	9,328	213,079	15,221	18,981	104,578	59	54,672	18,083	1,485	197,858
Colorado	6,563	136,090	9,620	5,204	5,483	497	112,014	2,994	278	126,470
Florida, Pennsylvania, West Virginia	12,977	765,597	18,496	5,898	8	--	740,991	204	--	747,101
Illinois and Kentucky	12,047	322,393	18,239	4,050	--	--	298,198	1,746	160	304,154
Kansas	29,858	1,367,949	42,763	8,719	1,476	91	1,274,698	39,904	298	1,325,186
Louisiana	135,522	5,831,487	189,541	97,510	86,889	1,104	4,718,880	732,262	5,301	5,641,946
Michigan	2,004	79,154	2,879	2,593	14,974	23	57,878	--	807	76,275
Mississippi and Alabama	875	29,694	1,261	1,940	2,808	269	15,819	7,659	—62	28,433
Montana, Utah, Alaska	3,948	156,203	5,734	6,163	104,999	1,374	25,568	8,578	3,787	150,469
Nebraska, North Dakota, South Dakota	1,910	34,463	2,717	4,727	8,492	43	18,195	--	289	31,746
New Mexico	39,408	1,037,160	56,109	47,665	7,821	2,389	844,874	73,105	5,197	981,051
Oklahoma	40,475	1,033,003	60,008	49,363	70,930	967	773,823	70,470	7,442	972,995
Texas	291,470	6,509,132	435,571	266,652	619,609	8,647	4,446,354	668,012	64,287	6,073,561
Wyoming	8,970	215,104	13,224	8,578	6,682	416	178,963	7,356	—115	201,880
Total	595,958	17,748,426	872,282	530,451	1,034,838	15,881	13,575,330	1,630,373	89,271	16,876,144

Table 10.—Comparison of actual firm requirements and firm curtailments for year April 1975 through March 1976 with projections for year April 1976 through March 1977

(Million cubic feet)

	Total for year April 1975–March 1976			Total for year April 1976–March 1977		
	Actual			Projected		
	Firm requirements	Volume curtailed	Percent curtailed	Firm requirements	Deficiency	Percent deficient
Alabama-Tennessee Natural Gas Co	29,232	3,054	10.45	32,482	6,239	19.21
Algonquin Gas Transmission Co	142,525	16,715	11.73	154,468	21,113	13.67
Arkansas Louisiana Gas Co	471,098	148,403	31.50	482,720	173,628	35.97
Bluefield Gas Co	1,090	--	--	1,151	--	--
Caprock Pipeline Co	1,744	--	--	1,823	--	--
Cities Service Gas Co	557,606	138,248	24.79	588,588	169,596	28.81
Colorado Interstate Gas Co	349,486	251	.07	372,312	11,191	3.01
Columbia Gas Transmission Corp	1,447,483	406,079	28.05	1,449,103	387,829	26.76
Commercial Pipeline Co., Inc	465	--	--	465	--	--
Consolidated Gas Supply Corp	654,749	52,050	7.95	691,160	74,464	10.77
East Tennessee Natural Gas Co	79,779	26,522	33.24	80,263	25,061	31.22
Eastern Shore Natural Gas Co	6,232	772	12.39	4,466	807	18.07
El Paso Natural Gas Co	1,385,824	221,289	15.97	1,428,994	402,813	28.19
Florida Gas Transmission Co	34,713	--	--	34,232	--	--
Gas Gathering Corp	2,462	--	--	[1]	[1]	[1]
Granite State Gas Transmission, Inc	3,603	--	--	3,733	--	--
Great Lakes Gas Transmission Co	88,859	--	--	88,741	--	--
Inter-City Minnesota Pipeline, Ltd	7,694	--	--	7,624	--	--
Kansas-Nebraska Natural Gas Co., Inc	85,447	--	--	84,686	--	--
Kentucky-West Virginia Gas Co	27,014	--	--	27,157	--	--
Lawrenceburg Gas Transmission Corp	5,523	535	9.69	5,523	1,980	35.85
Louisiana-Nevada Transit Co	4,229	402	9.51	4,620	735	15.91
McCulloch Interstate Gas Corp	6,345	--	--	4,591	--	--
Michigan Wisconsin Pipe Line Co	807,519	30,273	3.75	821,292	54,866	6.68
Mid Louisiana Gas Co	29,509	2,830	9.59	31,165	7,436	23.86
Midwestern Gas Transmission Co	345,446	55,576	16.09	327,381	49,563	15.14
Mississippi River Transmission Corp	202,633	--	--	225,818	--	--
Montana-Dakota Utilities Co	40,885	--	--	42,022	--	--
National Fuel Gas Supply Corp	188,933	--	--	227,371	25,976	11.42
Natural Gas Pipeline Co. of America	1,215,727	213,816	17.59	1,201,892	234,747	19.53
North Penn Gas Co	26,446	--	--	26,860	--	--
Northern Natural Gas Co	836,059	50,139	6.00	858,733	154,330	17.97
Northwest Pipeline Corp	450,310	49,345	10.96	458,328	47,720	10.41
Pacific Gas Transmission Co	[2] 367,194	--	--	360,365	--	--
Panhandle Eastern Pipeline Co	719,774	133,154	18.50	717,911	200,193	27.89
South Georgia Natural Gas Co	11,796	21	.18	14,797	307	2.07
South Texas Natural Gas Gathering Co	39,229	--	--	34,851	--	--
Southern Natural Gas Co	588,970	2,105	.36	588,970	43,879	7.45
Tennessee Gas Pipeline Co	1,321,687	203,647	15.41	1,337,432	259,016	19.37
Tennessee Natural Gas Lines, Inc	28,950	3,690	12.75	34,501	7,737	22.43
Texas Eastern Transmission Corp	995,671	270,052	27.12	1,030,879	297,106	28.82
Texas Gas Pipe Line Corp	2,386	--	--	2,465	--	--
Texas Gas Transmission Corp	753,818	129,550	17.19	771,162	219,584	28.47
Transcontinental Gas Pipe Line Corp	1,038,163	363,349	35.00	1,059,390	455,319	42.98
Transwestern Pipeline Co	367,668	89,068	24.23	366,664	127,119	34.67
Trunkline Gas Co	595,269	242,843	40.80	593,117	286,573	48.32
United Gas Pipe Line Co	1,582,935	721,944	45.61	1,605,954	839,937	52.30
Valley Gas Transmission, Inc	8,025	--	--	6,950	--	--
West Texas Gathering Co	93,292	--	--	83,821	--	--
Western Gas Interstate Co	8,878	108	1.22	9,580	78	.81
Western Transmission Corp	NA	NA	NA	NA	NA	NA
Total	18,060,374	3,575,830	19.80	18,388,573	4,586,942	24.94
Net requirements	14,211,357	XX	XX	14,556,473	XX	XX
Net curtailments	XX	2,800,700	XX	XX	3,624,684	XX
Net curtailments as a percent of net requirements	XX	XX	19.71	XX	XX	24.90

NA Not available. XX Not applicable.

[1] No data for 1976–77 submitted.

[2] Reported only actual and projected deliveries. No curtailment claimed.

Source: Federal Power Commission.

Table 11.—Comparison of actual and firm requirements and firm curtailments for heating season November 1975 through March 1976 with projections for year November 1976 through March 1977

(Million cubic feet)

	Heating Season November 1975–March 1976			Heating Season November 1976-March 1977		
	Actual			Projected		
	Firm requirements	Volume curtailed	Percent curtailed	Firm requirements	Deficiency	Percent deficient
Alabama-Tennessee Natural Gas Co	15,540	3,351	21.56	16,122	4,589	28.46
Algonquin Gas Transmission Co	84,914	12,047	14.19	89,691	13,773	15.36
Arkansas Louisiana Gas Co	218,743	66,627	30.46	228,473	73,472	32.16
Bluefield Gas Co	775	--	--	766	--	--
Caprock Pipeline Co	721	--	--	798	--	--
Cities Service Gas Co	280,467	72,626	25.89	297,292	89,420	30.08
Colorado Interstate Gas Co	181,430	98	.05	194,272	9,693	4.99
Columbia Gas Transmission Corp	847,997	244,875	28.88	847,878	235,597	27.79
Commercial Pipeline Co., Inc	301	--	--	301	--	--
Consolidated Gas Supply Corp	333,683	17,718	5.31	359,018	30,341	8.45
East Tennessee Natural Gas Co	40,282	10,172	25.25	40,472	10,023	24.77
Eastern Shore Natural Gas Co	3,442	726	21.09	1,914	785	41.01
El Paso Natural Gas Co	596,219	111,690	18.73	613,801	200,816	32.72
Florida Gas Transmission Co	19,193	--	--	18,857	--	--
Gas Gathering Corp	959	--	--	(1)	(1)	(1)
Granite State Gas Transmission, Inc	2,065	--	--	2,117	--	--
Great Lakes Gas Transmission Co	36,964	--	--	36,777	--	--
Inter-City Minnesota Pipelines, Ltd	3,932	--	--	3,614	--	--
Kansas-Nebraska Natural Gas Co., Inc	39,773	--	--	41,366	--	--
Kentucky-West Virginia Gas Co	11,458	--	--	11,672	--	--
Lawrenceburg Gas Transmission Corp	2,299	535	23.27	2,299	810	35.23
Louisiana-Nevada Transit Co	1,915	341	17.81	2,153	549	25.49
McCulloch Interstate Gas Co	2,333	--	--	1,719	--	--
Michigan Wisconsin Pipe Line Co	439,179	17,707	4.03	426,512	16,665	3.91
Mid Louisiana Gas Co	12,404	1,480	11.93	16,210	3,078	18.99
Midwestern Gas Transmission Co	140,130	21,048	15.02	139,284	23,300	16.73
Mississippi River Transmission Corp	118,187	--	--	133,444	--	--
Montana-Dakota Utilities Co	26,220	--	--	27,880	--	--
National Fuel Gas Supply Corp	121,137	--	--	135,691	13,349	9.84
Natural Gas Pipeline Co. of America	523,381	11,968	2.29	514,201	22,515	4.38
North Penn Gas Co	15,387	--	--	15,424	--	--
Northern Natural Gas Co	410,919	40,142	9.77	415,680	58,221	14.01
Northwest Pipeline Corp	222,600	44,262	19.88	223,640	43,462	19.43
Ohio River Pipeline Corp	(3)	(3)	(3)	(3)	(3)	(3)
Pacific Gas Transmission Co	162,312	--	--	153,839	--	--
Panhandle Eastern Pipeline Co	350,783	79,475	22.66	354,326	90,886	25.65
South Georgia Natural Gas Co	6,550	4	.06	8,157	106	1.30
South Texas Natural Gas Gathering Co	15,283	--	--	13,559	--	--
Southern Natural Gas Co	273,256	1,085	.40	273,256	2,828	1.03
Tennessee Gas Pipeline Co	622,873	96,547	15.50	617,918	104,416	16.90
Tennessee Natural Gas Lines, Inc	18,682	3,690	19.75	19,509	3,997	20.49
Texas Eastern Transmission Corp	443,660	104,012	23.44	452,895	116,208	25.66
Texas Gas Pipe Line Corp	668	--	--	1,118	--	--
Texas Gas Transmission Corp	341,211	34,176	10.02	353,419	83,339	23.58
Transcontinental Gas Pipe Line Corp	483,167	145,985	30.21	501,183	194,471	38.80
Transwestern Pipeline Co	152,515	43,883	28.77	151,511	58,265	38.46
Trunkline Gas Co	249,107	111,053	44.58	247,636	122,852	49.61
United Gas Pipe Line Co	691,618	300,773	43.49	705,188	359,527	50.98
Valley Gas Transmission, Inc	3,083	--	--	2,700	--	--
West Texas Gathering Co	39,700	--	--	35,030	--	--
Western Gas Interstate Co	3,145	103	3.28	3,664	65	1.77
Western Transmission Corp	NA	NA	NA	(2)	(2)	(2)
Total	8,612,562	1,598,199	18.56	8,754,246	1,987,418	22.70
Net requirements	6,985,378	XX	XX	7,161,481	XX	XX
Net curtailments	XX	1,265,534	XX	XX	1,595,237	XX
Net curtailments as a percent of net requirements	XX	XX	18.12	XX	XX	22.28

NA Not available. XX Not applicable.
[1] No filing made for Sept. 30, 1975.
[2] First report received was for period ending Apr. 30, 1976.
[3] Was granted exemption from further filing by Order dated Dec. 8, 1975.

Source: Federal Power Commission.

Table 12.—Comparison of actual interruptible sales and curtailments for year April 1975 through March 1976 with projected requirements and deficiencies for year April 1976 through March 1977
(Million cubic feet)

	Actual—Year April 1975–March 1976			Projected—Year April 1976–March 1977		
	Interruptible requirement	Volume curtailed	Percent curtailed	Interruptible requirement	Volume deficiency	Percent deficient
Alabama-Tennessee Natural Gas Co	11,128	10,523	94.56	10,364	10,238	98.78
Algonquin Gas Transmission Co	12,673	12,673	100.00	12,187	12,187	100.00
Arkansas Louisiana Gas Co	23,532	23,532	100.00	27,650	27,650	100.00
Bluefield Gas Co	121	--	--	154	--	--
Colorado Interstate Gas Co	45,573	15,765	34.59	42,884	17,201	40.11
East Tennessee Natural Gas Co	22,114	19,489	88.13	21,953	21,003	95.67
Eastern Shore Natural Gas Co	2,370	2,088	88.10	3,863	3,863	100.00
Florida Gas Transmission Co	121,306	65,578	54.06	110,828	55,557	50.13
Granite State Gas Transmission, Inc	663	233	34.88	437	204	46.68
Kansas-Nebraska Natural Gas Co., Inc	34,983	3,535	10.10	33,327	8,742	26.23
Louisiana-Nevada Transit Co	350	--	--	97	48	49.48
Mississippi River Transmission Corp	3,394	--	--	--	--	--
Montana-Dakota Utilities Co	18,355	--	--	18,193	--	--
Northern Natural Gas Co	8,217	--	--	--	--	--
Northwest Pipeline Corp	10,927	10,460	95.73	9,604	9,475	98.66
Panhandle Eastern Pipeline Co	70,979	38,350	54.03	67,511	35,406	52.44
South Georgia Natural Gas Co	21,254	7,338	34.53	19,753	11,956	60.53
Southern Natural Gas Co	165,802	125,274	75.56	165,802	134,618	81.19
Tennessee Natural Gas Lines, Inc	4,060	1,408	34.68	3,740	3,740	100.00
Texas Gas Transmission Corp	4,076	4,070	99.85	4,080	4,076	99.90
Transwestern Pipeline Co	864	--	--	746	--	--
Michigan Wisconsin Pipe Line Co	30,273	--	--	--	--	--
Natural Gas Pipeline Co. of America	22	--	--	14	--	--
Mid Louisiana Gas Co	--	--	--	1,206	1,206	100.00
Total	613,041	340,316	55.51	554,393	357,170	64.43
Net requirements and net curtailments	600,976	329,560	54.84	542,673	346,289	63.81

Source: Federal Power Commission.

Table 13.—Marketed production, interstate shipments and total consumption of natural gas in the United States, 1975

(Million cubic feet)

State and region	Marketed production	Interstate movements: Receipts	Interstate movements: Deliveries	Interstate movements: Net receipts (+) or deliveries (—)	Change in underground storage	Unaccounted for	Consumption
New England:							
Connecticut	--	155,741	91,871	63,870	—1,271	1,130	64,011
Maine, New Hampshire, Vermont	--	13,923	--	13,923	--	389	13,534
Massachusetts	--	183,191	23,271	159,920	2,185	3,768	153,967
Rhode Island	--	97,119	75,886	21,233	—541	—1,355	23,129
Total	--	449,974	191,028	258,946	373	3,932	254,641
Middle Atlantic:							
New Jersey	--	633,893	384,050	249,843	3,869	1,872	244,102
New York	7,628	826,501	250,455	576,046	—2,291	9,082	576,883
Pennsylvania	84,676	1,721,102	1,097,990	623,112	51,876	2,102	653,810
Total	92,304	3,181,496	1,732,495	1,449,001	53,454	13,056	1,474,795
East North Central:							
Illinois	1,440	2,112,982	933,892	1,179,090	69,306	3,324	1,107,900
Indiana	346	1,838,901	1,353,199	485,702	4,219	4,488	477,341
Michigan	102,113	826,505	10,153	816,352	28,093	3,309	887,063
Ohio	84,960	2,641,647	1,723,553	918,094	37,808	8,370	956,876
Wisconsin	--	464,271	93,154	371,117	—428	6,744	364,801
Total	188,859	7,884,306	4,113,951	3,770,355	138,998	26,235	3,793,981
West North Central:							
Iowa	--	1,309,669	952,599	357,070	5,661	5,611	345,798
Kansas	843,625	1,852,575	2,137,528	—284,953	13,968	3,214	541,490
Minnesota	--	562,613	224,678	337,935	—4	6,753	331,186
Missouri	30	1,535,678	1,158,783	376,895	—32	7,337	369,620
Nebraska	2,565	1,305,434	1,081,138	224,296	4,681	3,033	219,147
North Dakota	24,786	18,655	3,490	15,165	--	721	39,230
South Dakota	--	34,677	1,428	33,249	--	715	32,534
Total	871,006	6,619,301	5,559,644	1,059,657	24,274	27,384	1,879,005
South Atlantic:							
Delaware	--	20,894	1,221	19,673	549	521	18,603
Florida	44,383	246,566	--	246,566	--	1,684	289,265
Georgia	--	1,137,354	809,093	328,261	339	1,363	326,559
Maryland and District of Columbia	93	676,710	508,502	168,208	—1,437	3,806	165,932
North Carolina	--	659,826	541,933	117,893	109	2,962	114,822
South Carolina	--	786,871	659,826	127,045	—46	4,142	122,949
Virginia	6,723	791,615	672,911	118,704	—1,393	5,500	121,320
West Virginia	154,484	1,241,589	1,194,850	46,739	34,744	—1,214	167,693
Total	205,683	5,561,425	4,388,336	1,173,089	32,865	18,764	1,327,143

East South Central:							
Alabama	37,814	2,716,837	2,476,511	240,326	−98	13,456	264,782
Kentucky	60,511	3,684,713	3,513,056	171,657	12,038	7,137	212,993
Mississippi	74,345	5,683,382	5,521,131	162,251	−53	6,029	230,620
Tennessee	27	3,912,003	3,690,655	221,348	528	3,519	217,328
Total	172,697	15,996,935	15,201,353	795,582	12,415	30,141	925,723
West South Central:							
Arkansas	116,237	2,365,936	2,218,627	147,309	330	4,097	259,119
Louisiana	7,090,645	1,181,696	6,218,499	−5,036,803	58,685	17,028	1,978,129
Oklahoma	1,605,410	1,220,782	2,090,214	−869,432	2,983	4,168	728,827
Texas	7,485,764	544,730	3,622,568	−3,077,838	3,532	24,446	4,379,948
Total	16,298,056	5,313,144	14,149,908	−8,836,764	65,530	49,739	7,346,023
Mountain:							
Arizona	208	1,388,649	1,234,546	154,103	--	−1,911	156,222
Colorado	171,629	279,070	134,124	144,946	−2,465	1,648	317,392
Idaho	--	480,832	421,876	58,956	395	−1,890	60,451
Montana	40,734	56,241	23,653	32,588	−8,635	1,606	80,351
Nevada	--	61,463	--	61,463	--	212	61,251
New Mexico	1,217,430	717,762	1,629,530	−911,768	3,310	5,983	296,369
Utah	55,354	206,470	131,094	75,376	738	2,173	127,819
Wyoming	316,123	104,385	307,368	−202,983	3,234	9,494	100,412
Total	1,801,478	3,294,872	3,882,191	−587,319	−3,423	17,315	1,200,267
Pacific:							
Alaska	160,270	--	53,002	−53,002	15,555	5,718	85,995
California	318,308	1,569,946	--	1,569,946	4,066	36,118	1,848,070
Oregon	--	517,337	403,477	113,860	46	3,916	109,898
Washington	--	652,253	485,271	166,982	−99	2,747	164,334
Total	478,578	2,739,536	941,750	1,797,786	19,568	48,499	2,208,297
Total United States	20,108,661	[1]51,040,989	[2]50,160,656	880,333	344,054	235,065	20,409,875

[1] Includes receipts from Canada of 380,232 MMcf into Idaho; 262,443 MMcf into Washington; 253,638 MMcf into Minnesota; 42,180 MMcf into Montana; 5,497 MMcf into New York; 4,124 MMcf into Vermont; and from Algeria 4,893 MMcf into Massachusetts.

[2] Includes deliveries to Canada of 10,153 MMcf from Michigan; 66 MMcf from Montana and into Mexico; 6,230 MMcf from Texas; 3,233 MMcf from Arizona; and liquefied natural gas exports of 53,002 MMcf to Japan from Alaska.

Table 14.—Net interstate pipeline movements of natural gas in the United States
(Billion cubic feet at 14.73 psia)

	Net receipts from				Net deliveries to				Net receipts (+) and deliveries (−) [1]
	Within region		Outside region		Within region		Outside region		
	State	Quantity	State	Quantity	State	Quantity	State	Quantity	
New England:									
Connecticut	Massachusetts	8.2	New York	147.5	Rhode Island	91.9	XX	XX	63.8
Maine, New Hampshire, Vermont	do	9.8	Canada	4.1	XX	XX	XX	XX	13.9
Massachusetts	Rhode Island	75.9	Algeria	4.9	Rhode Island	5.2	XX	XX	168.2
	XX	XX	New York	102.4	New Hampshire	9.8	XX	XX	
Rhode Island	Connecticut	91.9	XX	XX	Connecticut	8.2	XX	XX	13.0
	Massachusetts	5.2	XX	XX	Massachusetts	75.9	XX	XX	
Total	XX	191.0	XX	258.9	XX	191.0	XX	XX	258.9
Middle Atlantic:									
New Jersey	New York	.4	XX	XX	New York	384.0	XX	XX	249.9
	Pennsylvania	633.5	XX	XX	XX	XX	XX	XX	
New York	New Jersey	384.0	Canada	5.5	New Jersey	.4	Connecticut	147.5	576.1
	Pennsylvania	437.0	XX	XX	Pennsylvania	.1	Massachusetts	102.4	
Pennsylvania	New York	.1	Maryland	505.9	New Jersey	633.5	Delaware	20.9	623.1
	XX	XX	Ohio	536.1	New York	437.0	West Virginia	6.6	
	XX	XX	West Virginia	679.0	XX	XX	XX	XX	
Total	XX	1,455.0	XX	1,726.5	XX	1,455.0	XX	277.4	1,449.1
East North Central:									
Illinois	Indiana	189.6	Iowa	632.5	Indiana	686.0	Missouri	.6	1,179.1
	XX	XX	Kentucky	373.5	Wisconsin	247.3	XX	XX	
	XX	XX	Missouri	917.4	XX	XX	XX	XX	
Indiana	Illinois	686.0	Kentucky	1,152.9	Illinois	189.6	XX	XX	485.7
	XX	XX	XX	XX	Ohio	1,163.6	XX	XX	
Michigan	Ohio	733.3	XX	XX	XX	XX	Canada	10.2	816.3
	Wisconsin	93.2	XX	XX	XX	XX	XX	XX	
Ohio	Indiana	1,163.6	Kentucky	1,215.7	Michigan	733.3	Kentucky	.3	918.2
	XX	XX	West Virginia	262.4	XX	XX	Pennsylvania	536.1	
	XX	XX	XX	XX	XX	XX	West Virginia	453.8	
Wisconsin	Illinois	247.3	Minnesota	217.0	Michigan	93.2	XX	XX	371.1
Total	XX	3,113.0	XX	4,771.4	XX	3,113.0	XX	1,001.0	3,770.4
West North Central:									
Iowa	Missouri	241.2	XX	XX	Minnesota	309.0	Illinois	632.5	356.7
	Nebraska	1,068.1	XX	XX	South Dakota	11.5	XX	XX	
	South Dakota	.4	XX	XX	XX	XX	XX	XX	
Kansas	XX	XX	Oklahoma	1,852.6	Missouri	821.8	Colorado	22.5	−284.8
	XX	XX	XX	XX	Nebraska	1,275.7	Oklahoma	17.4	
Minnesota	Iowa	309.0	Canada	253.6	North Dakota	7.7	Wisconsin	217.0	338.3
	South Dakota	.4	XX	XX	XX	XX	XX	XX	
Missouri	Kansas	821.8	Arkansas	713.3	Iowa	241.2	Illinois	917.4	376.9
	XX	XX	Illinois	.6	XX	XX	Oklahoma	.2	
Nebraska	Kansas	1,275.7	Colorado	6.1	Iowa	1,068.1	Colorado	2.5	224.2
	XX	XX	Wyoming	23.6	South Dakota	10.6	XX	XX	

North Dakota	Minnesota	7.7	Montana	11.0	Iowa	.4	Montana	3.5	14.8
South Dakota	Iowa	11.5	do	12.6	Minnesota	.4	do	(2)	33.6
	Nebraska	10.6	XX	XX	XX	XX	Wyoming	.7	
Total	XX	3,746.4	XX	2,873.4	XX	3,746.4	XX	1,813.7	1,059.7
South Atlantic:									
Delaware	XX	XX	Pennsylvania	20.9	Maryland	1.2	XX	XX	19.7
Florida	Georgia	7.4	Alabama	239.2	XX	XX	XX	XX	246.6
Georgia	XX	XX	do	1,137.4	Florida	7.4	Tennessee	14.8	328.3
	XX	XX	XX	XX	South Carolina	786.9	XX	XX	
Maryland and District of Columbia	Virginia	66.5	XX	XX	West Virginia	2.6	Pennsylvania	505.9	168.3
	Delaware	1.2	XX	XX	XX	XX	XX	XX	
	West Virginia	10.1	XX	XX	XX	XX	XX	XX	
North Carolina	South Carolina	659.8	XX	XX	Virginia	541.9	XX	XX	117.9
South Carolina	Georgia	786.9	XX	XX	North Carolina	659.8	XX	XX	127.1
Virginia	North Carolina	541.9	Tennessee	6.2	Maryland	10.1	XX	XX	118.6
	West Virginia	243.5	XX	XX	District of Columbia	655.4	XX	XX	
	XX	XX	XX	XX	West Virginia	7.5	XX	XX	
West Virginia	Maryland	2.6	Kentucky	771.0	Maryland	10.1	Ohio	262.4	46.5
	Virginia	7.5	Ohio	453.8	Virginia	243.5	Pennsylvania	679.0	
	XX	XX	Pennsylvania	6.6	XX	XX	XX	XX	
Total	XX	2,926.4	XX	2,635.1	XX	2,926.4	XX	1,462.1	1,173.0
East South Central:									
Alabama	Mississippi	2,716.8	XX	XX	Mississippi	4.9	Florida	239.2	240.2
	XX	XX	XX	XX	Tennessee	1,095.1	Georgia	1,137.4	
Kentucky	Tennessee	3,684.5	Ohio	.3	XX	XX	Illinois	373.5	171.7
	XX	XX	XX	XX	XX	XX	Indiana	1,152.9	
	XX	XX	XX	XX	XX	XX	Ohio	1,215.7	
	XX	XX	XX	XX	XX	XX	West Virginia	771.0	
Mississippi	Alabama	4.9	Louisiana	4,176.4	Alabama	2,716.8	Louisiana	2.3	162.3
	XX	XX	Arkansas	1,502.1	Tennessee	2,802.0	XX	XX	
Tennessee	Alabama	1,095.1	Georgia	14.8	Kentucky	3,684.5	Virginia	6.2	221.2
	Mississippi	2,802.0	XX	XX	XX	XX	XX	XX	
Total	XX	10,303.3	XX	5,693.6	XX	10,303.3	XX	4,898.2	795.4
West South Central:									
Arkansas	Louisiana	1,710.3	XX	XX	XX	XX	XX	XX	147.3
	Oklahoma	125.8	XX	XX	Louisiana	.7	Mississippi	1,502.1	
	Texas	529.9	XX	XX	Texas	2.6	Missouri	713.3	
Louisiana	Arkansas	.7	Mississippi	2.3	Arkansas	1,710.3	Mississippi	4,176.4	−5,036.7
	Texas	1,178.8	XX	XX	Texas	331.8	XX	XX	
Oklahoma	do	203.2	Kansas	17.4	Arkansas	125.8	Colorado	75.3	−869.4
	XX	XX	Missouri	.2	Texas	36.5	Kansas	1,852.6	
Texas	Arkansas	2.6	New Mexico	173.8	Arkansas	529.9	Mexico	6.2	−3,077.9
	Louisiana	331.8	XX	XX	Louisiana	1,178.8	New Mexico	704.5	
	Oklahoma	36.5	XX	XX	Oklahoma	1,203.2	XX	XX	
Total	XX	5,119.6	XX	193.7	XX	5,119.6	XX	9,030.4	−8,836.7

See footnotes at end of table.

Table 14.—Net interstate pipeline movements of natural gas in the United States—Continued

(Billion cubic feet at 14.73 psia)

	Net receipts from				Net deliveries to				Net receipts (+) and deliveries (—) [1]
	Within region		Outside region		Within region		Outside region		
	State	Quantity	State	Quantity	State	Quantity	State	Quantity	
Mountain:									
Arizona	New Mexico	1,385.3	XX	XX	Nevada	61.5	California	1,166.5	154.1
	Utah	3.4	XX	XX	New Mexico	3.4	Mexico	3.2	
Colorado	New Mexico	70.5	Kansas	22.5	do	9.9	Nebraska	6.1	144.9
	Wyoming	108.2	Nebraska	2.5	Utah	105.3	XX	XX	
	XX	XX	Oklahoma	75.3	Wyoming	12.8	XX	XX	
Idaho	Utah	36.8	Canada	380.2	XX	XX	Oregon	32.1	58.9
	Wyoming	63.8	XX	XX	XX	XX	Washington	389.8	
Montana	do	10.6	North Dakota	3.5	XX	XX	Canada	.1	32.5
	XX	XX	South Dakota	(2)	XX	XX	North Dakota	11.0	
	XX	XX	Canada	42.1	XX	XX	South Dakota	12.6	
Nevada	Arizona	61.5	XX	XX	XX	XX	XX	XX	61.5
New Mexico	do	3.4	Texas	704.5	Arizona	1,385.3	Texas	173.8	—911.8
	Colorado	9.9	XX	XX	Colorado	70.5	XX	XX	
Utah	do	105.3	XX	XX	Arizona	3.4	XX	XX	75.4
	Wyoming	101.2	XX	XX	Idaho	36.8	XX	XX	
	XX	XX	XX	XX	Wyoming	90.9	XX	XX	
Wyoming	Colorado	12.8	South Dakota	.7	Colorado	108.2	Nebraska	23.6	—203.0
	Utah	90.9	XX	XX	Idaho	63.8	XX	XX	
	XX	XX	XX	XX	Montana	10.6	XX	XX	
	XX	XX	XX	XX	Utah	101.2	XX	XX	
Total	XX	2,063.6	XX	1,231.3	XX	2,063.6	XX	1,818.8	—587.5
Pacific:									
Alaska	XX	XX	XX	XX	XX	XX	Japan	[3]53.0	—53.0
California	Oregon	403.5	Arizona	1,166.5	XX	XX	XX	XX	1,570.0
Oregon	Washington	485.3	Idaho	32.1	California	403.5	XX	XX	113.9
Washington	XX	XX	do	389.8	Oregon	485.3	XX	XX	166.9
	XX	XX	Canada	262.4	XX	XX	XX	XX	
Total	XX	888.8	XX	1,850.8	XX	888.8	XX	53.0	1,797.8
United States [1]	XX	XX	XX	XX	XX	XX	Canada	10.2	880.3
	XX	XX	Canada	947.9	XX	XX	Japan	[3]53.0	
	XX	XX	Algeria	4.9	XX	XX	Mexico	9.4	
Total	XX	XX	XX	952.8	XX	XX	XX	72.6	880.3

[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.
[3] Liquefied natural gas.

Table 15.—Estimated total proved reserves of natural gas in the United States

(Million cubic feet at 14.73 psia and 60° F)

State	Reserves as of Dec. 31, 1974	Changes in reserves during 1975						Reserves as of December 31, 1975				
		Revisions	Extensions	New field discoveries	New reservoir discoveries in old fields	Net change in underground storage[1]	Production[2]	Total gas	Nonassociated	Associated-dissolved	Underground storage[3]	Net change in reserves
Alabama	507,370	80,613	34,757	169,066	--	--	20,825	770,981	732,799	38,182	--	263,611
Alaska	31,866,612	216,369	101,000	22,000	--	--	155,232	32,050,749	5,727,699	26,323,050	--	184,137
Arizona	1,141	397	--	--	--	--	249	1,559	479	1,080	--	148
Arkansas	2,113,404	−38,950	25,855	4,000	6,700	617	118,353	1,993,273	1,836,725	132,373	24,175	−120,131
California[4]	5,194,592	390,881	194,169	11,100	29,515	−4,285	331,945	5,484,027	2,249,260	2,906,497	328,270	289,435
Colorado	1,881,695	−91,174	250,982	11,041	839	4,937	165,303	1,893,017	1,659,151	204,572	29,294	11,322
Florida	308,866	1,683	--	--	--	--	43,645	266,904	--	266,904	--	−41,962
Illinois	399,414	−15,814	--	--	--	−1,492	1,304	380,804	1,100	3,626	376,078	−18,610
Indiana	64,141	−2,552	--	--	--	−1,607	143	59,839	2,010	21	57,808	−4,302
Iowa	80,465	--	--	--	--	15,970	--	96,435	--	--	96,435	15,970
Kansas	11,704,731	1,590,937	171,473	28,456	6,167	6,353	846,936	12,661,181	12,405,912	150,413	104,856	956,450
Kentucky	844,002	−331	14,251	--	277	14,193	59,762	812,630	638,055	42,985	131,590	−31,372
Louisiana[4 5]	64,052,445	877,251	1,712,942	1,208,503	601,519	37,505	7,180,742	61,309,423	51,471,615	9,626,511	211,297	−2,743,022
Maryland	42,034	--	--	--	--	642	88	42,588	4,114	--	38,474	554
Michigan	1,458,254	36,927	--	155,967	--	61,304	105,703	1,606,749	483,268	536,766	586,715	148,495
Minnesota	3,188	--	--	--	--	−63	--	3,125	--	--	3,125	−63
Mississippi	1,079,420	7,953	103,939	33,687	73,052	−10,619	79,805	1,207,627	1,032,310	94,201	81,116	128,207
Missouri	17,684	−7	--	--	--	−120	30	17,527	8	--	17,519	−157
Montana	901,260	13,701	13,617	27,347	--	26,485	52,424	929,986	686,350	73,912	169,724	28,726
Nebraska	54,609	245	308	271	--	4,435	4,050	55,818	12,748	7,214	35,856	1,209
New Mexico	11,944,902	446,806	422,575	41,552	21,886	2,388	1,120,815	11,759,294	9,442,073	2,287,375	29,846	−185,608
New York	165,546	50	44,850	3,000	--	9,029	6,632	215,843	103,446	38	112,359	50,297
North Dakota	432,682	1,347	2,551	8,242	77	--	28,051	416,848	5,715	411,133	--	−15,834
Ohio	1,308,210	--	89,910	290	3,980	37,442	85,822	1,354,010	795,987	173,033	384,990	45,800
Oklahoma	13,390,312	307,183	878,459	106,208	67,133	6,141	1,672,408	13,083,028	10,250,503	2,612,725	219,800	−307,284
Pennsylvania	1,492,145	--	219,750	2,376	3,149	49,812	84,772	1,682,460	1,074,414	11,722	596,324	190,315
South Dakota	213	--	--	20	--	--	40	193	--	193	--	−20
Tennessee	5,907	--	1,700	1,500	600	--	27	9,680	9,407	273	--	3,773
Texas[4]	78,540,717	−3,083,061	1,492,079	507,372	609,411	12,192	7,041,856	71,036,854	50,638,399	20,242,346	156,109	−7,503,863
Utah	1,031,409	−87,304	25,042	6,401	228	240	58,583	917,433	493,885	420,266	3,282	−113,976
Virginia	44,707	--	8,550	300	--	--	6,092	47,465	47,465	--	--	2,758
Washington	17,182	--	--	--	--	1,149	--	18,331	--	--	18,331	1,149
West Virginia	2,265,581	68	154,525	2,292	8,130	28,529	147,789	2,311,336	1,887,516	50,853	372,967	45,755
Wyoming	3,917,387	−269,769	64,149	72,391	216,761	1,384	299,144	3,703,159	3,093,138	555,715	54,306	−214,228
Total United States	237,132,497	383,449	6,027,433	2,423,382	1,649,424	302,561	19,718,570	228,200,176	156,785,551	67,173,979	4,240,646	−8,932,321

See footnotes at end of table.

Table 15.—Estimated total proved reserves of natural gas in the United States—Continued

(Million cubic feet at 14.73 psia and 60° F)

State	Reserves as of Dec. 31, 1974	Changes in reserves during 1975						Reserves as of December 31, 1975				
		Revisions	Extensions	New field discoveries	New reservoir discoveries in old fields	Net change in underground storage [1]	Production [2]	Total gas	Nonassociated	Associated-dissolved	Underground storage [3]	Net change in reserves
Gulf of Mexico detail: [6]												
Louisiana	32,420,492	2,982,205	1,417,045	998,981	304,614	--	3,907,590	34,215,747	29,904,289	4,311,458	--	1,795,255
Texas	2,927,349	215,667	21,881	132,954	30,298	--	211,254	3,116,895	2,974,822	142,073	--	189,546
Total Gulf of Mexico	35,347,841	3,197,872	1,438,926	1,131,935	334,912	--	4,118,844	37,332,642	32,879,111	4,453,531	--	1,984,801

[1] The net difference between gas stored in and gas withdrawn from underground storage reservoirs, inclusive of adjustments and native gas transferred from other reserve categories. (Adjustments include change of reporting basis starting in 1974 to report only gas reserves considered recoverable, in effect, reducing gas reserves by 1,024,140 MMcf that would have been reported since 1972 using the former basis.)

[2] Preliminary net production.

[3] Proved recoverable gas contained in underground gas storage reservoirs, including native and net injected gas. (First reported on a recoverable basis in 1973.)

[4] Includes offshore.

[5] Reported quantities include reserves estimated to be recoverable from some reservoirs considered natural gas bearing based on electrical logs, core data and other available engineering and geological data.

[6] Included with Louisiana and Texas.

Source: Committee on Natural Gas Reserves, American Gas Association.

Table 16.—Underground storage statistics, December 31, 1975

(Million cubic feet at 14.73 psia and 60° F)

State	Number of reservoirs	Type of reservoir: Non-associated gas	Oil and gas	Oil	Water	Other	Number of wells	Total stored gas in underground reservoirs (million cubic feet)	Total reservoir capacity (million cubic feet)
Arkansas	5	5	--	--	--	--	22	11,920	42,571
California	8	5	3	--	--	--	355	202,157	424,494
Colorado	7	4	2	--	--	[1]1	66	18,822	37,280
Illinois	31	8	--	1	22	--	1,580	674,629	974,706
Indiana	27	17	--	--	10	--	892	74,363	161,488
Iowa	8	--	--	--	8	--	356	183,465	354,500
Kansas	17	17	--	--	--	--	771	98,135	127,495
Kentucky	21	15	2	--	4	--	1,144	102,236	203,068
Louisiana	6	6	--	--	--	--	135	196,501	274,022
Maryland	1	1	--	--	--	--	68	26,004	64,770
Michigan	40	35	1	1	--	[2]3	2,642	498,265	861,379
Minnesota	1	--	--	--	1	--	46	4,925	20,000
Mississippi	4	3	--	--	--	[2]1	69	65,465	108,077
Missouri	1	--	--	--	1	--	82	29,278	45,000
Montana	5	5	--	--	--	--	134	133,086	213,152
Nebraska	1	1	--	--	--	--	15	27,487	39,270
New Mexico	2	1	--	--	1	--	46	23,349	35,125
New York	19	19	--	--	--	--	766	109,858	146,609
Ohio	22	22	--	--	--	--	3,102	387,470	507,797
Oklahoma	12	11	1	--	--	--	221	231,776	337,143
Pennsylvania	68	68	--	--	--	--	2,071	607,714	755,497
Texas	18	7	6	5	--	--	223	110,421	334,265
Utah	2	--	--	--	2	--	12	3,990	3,990
Washington	2	--	--	--	2	--	71	21,784	23,438
West Virginia	38	37	1	--	--	--	1,328	391,193	455,018
Wyoming	10	9	--	--	1	--	29	42,691	93,385
Total	376	296	16	7	52	5	16,246	4,276,984	6,643,539

[1] Coal.
[2] Salt.

Source: American Gas Association.

Table 17.—Natural gas stored and withdrawal statistics
(Million cubic feet at 14.73 psia)

State	1974			1975		
	Total stored	Total withdrawn	Net stored	Total stored	Total withdrawn	Net stored
Alabama	410	621	−211	434	532	−98
Alaska	13,253	--	13,253	15,555	--	15,555
Arkansas	1,783	1,448	335	1,555	1,225	330
California	129,945	50,411	79,534	105,167	101,101	4,066
Colorado	11,444	12,354	−910	13,420	15,885	−2,465
Connecticut	740	1,241	−501	746	2,017	−1,271
Delaware	--	--	--	2,012	1,463	549
Georgia	123	33	90	366	27	339
Idaho	112	--	112	395	--	395
Illinois	232,284	184,540	47,744	294,689	225,383	69,306
Indiana	36,070	37,288	−1,218	43,845	39,626	4,219
Iowa	56,505	44,114	12,391	59,065	53,404	5,661
Kansas	45,642	37,155	8,487	52,045	38,077	13,968
Kentucky	50,903	49,047	1,856	70,609	58,571	12,038
Louisiana	81,960	79,140	2,820	149,966	91,281	58,685
Maryland	11,016	9,724	1,292	6,830	8,267	−1,437
Massachusetts	403	2,110	−1,707	3,912	1,727	2,185
Michigan	287,776	305,092	−17,316	322,960	294,867	28,093
Minnesota	1,502	979	523	839	843	−4
Mississippi	25,439	25,409	30	27,345	27,398	−53
Missouri	9,413	8,225	1,188	8,658	8,690	−32
Montana	19,791	14,347	5,444	13,090	21,725	−8,635
Nebraska	5,667	363	5,304	5,459	778	4,681
New Jersey	3,953	3,329	624	6,378	2,509	3,869
New Mexico	12,589	58	12,531	4,160	850	3,310
New York	56,403	53,712	2,691	43,207	45,498	−2,291
North Carolina	2,626	2,483	143	2,019	1,910	109
Ohio	152,580	178,990	−26,410	183,032	145,224	37,808
Oklahoma	70,076	78,355	−8,279	87,459	84,476	2,983
Oregon	5	--	5	46	--	46
Pennsylvania	265,901	306,548	−40,647	332,183	280,307	51,876
Rhode Island	243	654	−411	137	678	−541
South Carolina	80	53	27	70	116	−46
Tennessee	1,750	804	946	2,325	1,797	528
Texas	54,705	55,309	−604	54,333	50,801	3,532
Utah	999	317	682	1,340	602	738
Virginia	112	258	−146	1,079	2,472	−1,393
Washington	7,993	5,510	2,483	12,009	12,108	−99
West Virginia	124,988	141,995	−17,007	161,604	126,860	34,744
Wisconsin	--	331	−331	--	428	−428
Wyoming	7,025	8,199	−1,174	13,276	10,042	3,234
Total	1,784,209	1,700,546	83,663	2,103,619	1,759,565	344,054

Table 18.—Quantity and value of marketed production of natural gas in the United States

State	1974 Quantity (million cubic feet) [1]	1974 Value (thousands)	1974 Average wellhead value (cents per Mcf)	1975 Quantity (million cubic feet) [1]	1975 Value (thousands)	1975 Average wellhead value (cents per Mcf)
Alabama	27,865	$20,704	74.3	37,814	$32,898	87.0
Alaska	128,935	21,919	17.0	160,270	48,402	30.2
Arizona	224	45	20.0	208	58	28.0
Arkansas	123,975	32,234	26.0	116,237	40,334	34.7
California	365,354	160,756	44.0	318,308	222,816	70.0
Colorado	144,629	28,926	20.0	171,629	44,624	26.0
Florida	38,137	20,441	53.6	44,383	43,185	97.3
Illinois	1,436	574	40.0	1,440	1,008	70.0
Indiana	176	25	14.0	346	135	39.0
Kansas	886,782	147,206	16.6	843,625	145,103	17.2
Kentucky	71,876	35,938	50.0	60,511	32,676	54.0
Louisiana	7,753,631	2,380,365	30.7	7,090,645	2,999,179	42.3
Maryland	133	32	24.0	93	25	27.0
Michigan	69,133	34,843	50.4	102,113	64,740	63.4
Mississippi	78,787	23,242	29.5	74,345	36,875	49.6
Missouri	33	10	31.4	30	10	34.0
Montana	54,873	13,883	25.3	40,734	17,638	43.3
Nebraska	2,538	863	34.0	2,565	1,388	54.1
New Mexico	1,244,779	390,861	31.4	1,217	493,059	40.5
New York	4,990	2,745	55.0	7,628	5,645	74.0
North Dakota	31,206	6,210	19.9	24,786	5,701	23.0
Ohio	92,055	44,371	48.2	84,960	59,982	70.6
Oklahoma	1,638,942	458,904	28.0	1,605,410	513,731	32.0
Pennsylvania	82,637	36,360	44.0	84,676	57,156	67.5
Tennessee	17	6	36.0	27	12	43.0
Texas	8,170,798	2,541,118	31.1	7,485,764	3,885,112	51.9
Utah	50,522	20,815	41.2	55,354	26,570	48.0
Virginia	7,096	3,619	51.0	6,723	3,462	51.5
West Virginia	202,306	66,356	32.8	154,484	57,005	36.9
Wyoming	326,657	80,031	24.5	316,123	106,533	33.7
Total	21,600,522	6,573,402	30.4	20,108,661	8,945,062	44.5

[1] Marketed production natural gas represents gross withdrawals less gas used for repressuring and quantities vented and flared.

Source: Figures based on reports received from State agencies and Bureau of Mines estimates.

Table 19.—Average wholesale prices for 14 large cities and adjacent areas

(Cents per Mcf)

Standard metropolitan statistical area	July 1, 1969	July 1, 1970	July 1, 1971	July 1, 1972 [1]	July 1, 1973 [1]	July 1, 1974 [1]	July 1, 1975 [1]
Baltimore	41.98	43.98	52.60	53.22	54.51	65.21	96.40
Boston	68.64	65.76	76.17	76.73	83.61	114.10	133.14
Chicago	29.63	31.93	36.04	36.65	44.76	55.66	72.68
Cleveland	40.50	44.64	49.09	52.90	52.14	62.72	73.72
Detroit	38.82	39.91	41.48	47.34	51.21	58.51	82.14
Los Angeles [2]	31.60	34.63	38.78	40.74	42.25	50.53	74.57
Minneapolis-St. Paul	36.29	36.80	42.59	45.14	52.03	55.67	67.93
Newark (and New Jersey suburbs of New York)	43.90	43.45	47.18	53.61	56.91	77.02	97.84
New York	41.52	42.51	45.98	51.93	54.17	71.64	93.78
Philadelphia	43.20	43.42	46.90	53.28	56.64	76.53	95.80
Pittsburgh	38.37	43.44	49.78	49.26	48.24	65.07	75.30
St. Louis (Missouri portion only)	33.77	37.26	47.62	49.37	53.96	61.18	90.28
San Francisco-Oakland [2]	30.81	33.67	35.17	36.52	39.24	49.01	94.27
Washington, D.C	47.13	51.06	61.64	60.29	59.74	71.60	103.51

[1] Reflects contingent rates in effect subject to subsequent reduction and refunds as of July 1 of year indicated.

[2] Deliveries are not at city gates. Distributors must transport from State lines (California-Oregon and California-Arizona).

Source: Federal Power Commission.

Table 20.—Average price of residential heating gas by area 1968–76

(Dollars per 10 therms)

Standard metropolitan statistical area	January 1968	January 1969	January 1970	January 1971	January 1972	January 1973	January 1974	January 1975	January 1976
Atlanta	0.824	0.824	0.824	0.824	1.009	1.107	1.117	1.218	1.411
Baltimore	1.225	1.265	1.332	1.327	1.513	1.513	1.564	2.017	2.409
Boston	1.426	1.436	1.499	1.568	1.802	1.814	2.103	2.538	3.155
Buffalo	.870	.905	.932	1.028	1.218	1.223	1.461	1.854	1.947
Chicago-Northwest Indiana	.944	.895	.965	1.021	1.110	1.130	1.207	1.432	1.623
Cincinnati	.771	.752	.799	.812	.943	.974	.992	1.328	1.555
Cleveland	.729	.732	.747	.858	.896	.938	.928	1.229	1.405
Dallas	.740	.755	.847	.849	.863	.890	.888	.914	1.512
Detroit	.850	.850	.866	.873	.953	.998	1.155	1.350	1.869
Houston	.772	.871	.875	.928	.957	1.000	1.042	1.499	2.229
Kansas City	.569	.609	.681	.669	.717	.720	.771	.929	1.053
Milwaukee	1.067	1.101	1.247	1.272	1.350	.391	1.446	1.575	2.157
Minneapolis-St. Paul	.810	.851	.877	.913	.998	1.073	1.119	1.354	1.439
New York-Northeast New Jersey	1.290	1.299	1.320	1.363	1.568	1.660	1.887	2.293	3.015
Philadelphia	1.379	1.380	1.381	1.430	1.459	1.531	1.714	2.009	2.380
Pittsburgh	.809	.845	.880	.970	1.018	1.064	1.144	1.418	1.607
St. Louis	.838	.842	.916	.979	1.093	1.097	1.173	1.454	1.654
San Francisco-Oakland	.608	.610	.622	.714	.762	.840	.920	1.291	1.530
Seattle	1.150	1.150	1.159	1.159	1.249	1.270	1.530	1.886	2.421
Washington, D.C	1.287	1.315	1.362	1.360	1.505	1.569	1.599	2.149	2.482
U.S. average	.838	.844	.874	.920	1.010	1.047	1.133	1.379	1.943

Source: Bureau of Labor Statistics, monthly release, "Retail Prices and Indexes of Fuels and Electricity", table 7; U.S. average table 2.

Table 21.—Liquefied natural gas (LNG) exports, 1975[1]

	Phillips Petroleum Co.	Marathon Oil Co.	Total
Volume shipped:			
Barrels ---------- 42 U.S. gallons --	10,603,275	4,566,111	15,169,386
Thousand-cubic-foot equivalent per 14.73 psia --	37,031,736	15,970,229	53,001,965
Average Btu per cubic foot ----------	1,010	1,010	1,010
Value:			
Total dollars ----------	51,075,578	22,044,291	73,119,869
Average price -- cents per thousand cubic feet -	137.92	138.03	137.96

[1] All shipments were to Japan from Port Nikiski, Alaska.

Source: Federal Power Commission.

Table 22.—Natural gas exports via pipeline: Volume, value, and unit cost, 1974–75

Exporting companies	Point of exit	Gas volume (thousand cubic feet at 14.73 psia and 60° F)		Percent change	Value (thousands)		Average price (cents per thousand cubic feet)	
		1974	1975		1974	1975	1974	1975
EXPORTS TO CANADA								
Interstate company: Panhandle Eastern Pipe Line Co	Detroit River-River Rouge, Mich	13,231,763	10,153,178	(23.3)	$8,473,472	$7,918,872	64.04	77.99
Intrastate company: The Montana Power Co	Sweetgrass, Mont	31,030	66,173	113.3	14,262	54,366	45.96	82.16
Total Canada [1]		13,262,793	10,219,351	(22.9)	8,478,734	7,973,238	64.00	78.02
EXPORTS TO MEXICO								
Interstate company: El Paso Natural Gas Co	Naco, Ariz	4,217,318	3,223,030	(23.6)	2,431,556	2,473,125	57.66	76.73
Intrastate companies:								
Del Norte Natural Gas Co	El Paso, Tex	3,526,592	3,713,297	5.3	2,301,608	3,107,474	65.26	83.69
Texas Gas Utilities Co	Eagle Pass, Tex	1,462,862	774,672	(47.0)	1,201,992	1,254,534	82.17	161.94
Do	Laredo, Tex	2,953,605	558,782	(81.1)	2,482,932	897,866	84.06	160.68
United Gas, Inc	do	1,108,075	1,183,620	6.8	934,487	2,045,010	84.33	172.78
Total		9,051,134	6,230,371	(31.2)	6,921,019	7,304,884	76.47	117.25
Total Mexico		13,268,452	9,453,401	(28.8)	9,352,575	9,778,009	70.49	103.43
Grand total exports		26,531,245	19,672,752	(25.9)	17,840,309	17,751,247	67.24	90.23

[1] In addition Northern Natural Gas Co. delivered 15,768,132 Mcf gas produced from the Tiger Ridge area, Mont., to Consolidated Natural Gas Co. at a point on the Montana-Saskatchewan border for transportation and received 15,767,658 Mcf gas into its line again on Minnesota-Manitoba border, near Emerson, Manitoba.

Source: Federal Power Commission.

Table 23.—Natural gas imports via pipeline: Volume, value, and unit cost, 1974–75

Importing companies	Point of entry	Gas volume (thousand cubic feet at 14.73 psia and 60° F) 1974	Gas volume 1975	Percent change	Value (thousands) 1974	Value (thousands) 1975	Average price (cents per thousand cubic feet) 1974	Average price 1975
IMPORTS FROM CANADA								
Interstate companies:								
Great Lakes Gas Transmission Co	Noyes, Minn	[1]110,278,903	[1]109,885,018	(0.4)	$46,398,380	$130,509,311	42.07	118.77
Inter-City Minnesota Pipeline Ltd	Warroad, Minn.[2]	[3]7,773,545	[3]7,206,073	(7.3)	4,562,883	8,013,217	58.70	111.20
Michigan Wisconsin Pipe Line Co	Noyes, Minn	[3]18,250,000	18,250,000	--	7,818,419	21,634,077	42.84	118.54
Midwestern Gas Transmission Co	do	119,797,168	118,296,967	(1.3)	49,591,646	139,970,348	41.40	118.32
Northwest Pipeline Corp	Summas, Wash.[4]	238,905,328	212,166,893	(11.2)	168,949,677	254,016,231	70.72	119.72
Do	Eastport, Idaho[4]	47,841,435	50,275,976	5.1	22,991,765	61,423,853	48.06	122.17
Pacific Gas Transmission Co	do	357,657,900	380,232,414	6.3	198,151,071	469,714,574	55.40	123.53
Total interstate[5]		900,504,279	896,313,341	(.5)	498,463,841	1,085,281,611	55.35	121.08
Intrastate companies:								
The Montana Power Co	Whitlash, Mont	18,692,519	13,441,579	(28.1)	9,164,840	14,969,866	49.03	111.37
Do	Babb, Mont	29,418,757	28,738,911	(2.3)	15,696,321	35,683,760	53.35	124.17
St. Lawrence Gas Co. Inc	Massena, N.Y	5,556,108	5,496,658	(1.1)	4,209,952	6,657,943	75.77	121.13
Vermont Gas Systems, Inc	Highgate, Vt	4,890,860	4,124,171	(15.7)	3,332,048	4,872,330	68.13	118.14
Total intrastate		58,558,244	51,801,319	(11.5)	32,403,161	62,183,899	55.33	120.04
Total Canada		959,062,523	948,114,660	(1.1)	530,867,002	1,147,465,510	55.35	121.03
IMPORTS FROM MEXICO								
Interstate company: Texas Eastern Transmission Corp	McAllen, Tex	222,432	--	(100.0)	37,309	--	16.77	--
Grand total imports		959,284,955	948,114,660	(1.1)	530,904,311	1,147,465,510	55.34	121.03

[1] Includes the difference between the 288,533,155 Mcf received from TransCanada Pipelines Ltd. for transportation and the 287,255,222 Mcf redelivered to TransCanada at St. Clair and Sault Ste. Marie, Mich.
[2] Second port of entry is International Falls, Minn.
[3] Includes the difference between the 10,044,212 Mcf received from TransCanada Pipelines Ltd. for transportation and 9,653,783 Mcf redelivered to TransCanada Pipelines Ltd. at Baudette, Minn.
[4] Volumes and cost data include the gas imports reported by El Paso Natural Gas Co. for 1974 and the month of January 1975 after which Northwest Pipeline Corp. imported the volumes formerly imported by El Paso.
[5] In addition, Tennessee Gas Pipeline Co. exchanged 211,524 gas with TransCanada Pipelines Ltd. at Niagara, N.Y.

Table 24.—Liquefied natural gas (LNG) imports, 1975 [1]

Volume received:	
42-gallon barrels	1,401,149
Mcf equivalent at 14.73 psia	4,892,949
Average Btu per cubic foot	1,057
Value:	
Total dollars	3,640,515
Average price cents per Mcf	74.40

[1] All shipments were from Algeria to the Distrigas Corp. terminal at Everett, Mass.

Source: Federal Power Commission.

Table 25.—Natural gas: World production by country
(Million cubic feet)

Country [1]	1973		1974		1975 [p]	
	Gross production [2]	Marketed production [3]	Gross production [2]	Marketed production [3]	Gross production [2]	Marketed production [3]
North America:						
Barbados	[e] 140	127	[r] [e] 90	85	[e] 125	120
Canada	3,566,650	3,119,461	3,497,225	3,045,506	3,488,798	3,075,693
Cuba	[e] 920	494	[e] 930	671	[e] 930	[e] 700
Mexico	676,750	541,772	744,673	560,911	786,458	583,876
Trinidad and Tobago	113,500	[r] 64,353	127,686	58,240	102,395	[e] 55,000
United States	24,067,202	22,647,549	22,849,793	21,600,522	21,103,530	20,108,661
South America:						
Argentina	314,793	[r] 237,631	332,839	255,748	362,860	271,639
Bolivia	151,199	57,857	144,128	60,539	137,297	66,374
Brazil	41,668	8,970	52,970	17,587	57,386	[e] 20,000
Chile	[4] 260,496	144,937	[4] 248,687	127,503	[4] 250,625	185,751
Colombia	113,229	65,045	116,634	65,792	120,754	65,905
Ecuador	[r] 11,477	989	11,159	[e] 1,000	10,559	[e] 1,100
Peru	64,005	34,184	69,848	35,697	67,037	[e] 35,000
Venezuela	1,745,702	459,936	1,639,511	475,969	1,342,234	450,295
Europe:						
Albania	[5] 6,710	6,710	[e] [5] 7,170	[e] 7,170	[e] [5] 7,190	[e] 7,190
Austria [6]	80,163	77,335	77,930	73,957	83,305	79,869
Belgium [7]	[5] 1,949	1,949	[5] 2,246	2,246	[5] 1,822	1,822
Bulgaria	[5] 7,840	7,840	[5] 6,357	6,357	[e] [5] 5,300	[e] 5,300
Czechoslovakia [6]	[5] 36,798	36,798	[5] 34,432	34,432	[5] 30,088	30,088
Denmark [e]	2,191	([8])	1,034	([8])	1,992	([8])
France	387,753	261,680	392,697	269,414	382,159	259,773
Germany, East	[5] 247,625	247,625	[5] 273,052	273,052	[5] 280,000	280,000
Germany, West [6]	706,131	705,895	734,787	713,202	645,445	639,414
Hungary	[r] [5] 170,251	[r] [9] 170,251	[5] 180,139	[9] 180,139	[5] 183,000	[9] 183,000
Italy	[5] 540,993	540,993	[5] 540,363	540,363	[5] 514,252	514,252
Netherlands	2,501,467	2,494,687	2,956,707	2,956,671	[5] 3,208,428	3,208,428
Norway	16,759	([8])	19,700	([8])	106,800	([8])
Poland [6]	[5] 212,840	212,840	[5] 202,670	202,670	[5] 210,580	210,580
Romania	[r] 1,032,526	[r] 980,083	1,063,495	1,011,513	[e] 1,165,526	953,527
Spain	[5] 114	114	[5] 35	35	[5] 42	42
U.S.S.R	[e] 8,800,000	[r] 8,345,735	[e] 9,700,000	9,201,299	[e] 10,760,000	10,205,890
United Kingdom [6]	[5] 1,018,400	1,018,400	[5] 1,230,039	1,230,039	[5] 1,208,180	1,208,180
Yugoslavia	[5] 46,933	46,933	[5] 51,100	51,100	[5] 54,879	54,879
Africa:						
Algeria	[r] [e] 760,000	167,567	700,251	198,502	739,874	[e] 210,000
Angola [e]	36,000	2,300	[e] 37,500	[e] 2,400	[e] 35,000	2,300
Congo (Brazzaville)	[r] 15,800	[r] 551	23,000	664	14,000	591
Egypt	30,700	[e] 3,100	49,700	[e] 15,000	50,600	[e] 40,000
Gabon	[r] [e] 56,900	[r] 10,000	62,507	22,495	60,458	9,252
Libya	[r] 575,026	[9] 385,246	425,363	[9] 345,199	489,035	[9] 382,633
Morocco	[r] 2,962	[r] 2,295	2,841	2,084	2,501	[e] 2,000
Nigeria	735,813	10,700	1,017,774	14,255	658,839	16,094
Rwanda	[5] 35	35	[5] 35	35	[e] [5] 35	[e] 35
Tunisia	4,513	4,026	[e] 7,600	7,098	35,315	7,497

See footnotes at end of table.

Table 25.—Natural gas: World production by country—Continued

(Million cubic feet)

Country [1]	1973 Gross production [2]	1973 Marketed production [3]	1974 Gross production [2]	1974 Marketed production [3]	1975 [p] Gross production [2]	1975 [p] Marketed production [3]
Asia:						
Afghanistan	[r] [5]110,005	[r] 110,005	[5]113,006	113,006	105,944	98,881
Bahrain	82,855	[10]56,575	100,010	[10] 68,255	101,546	73,343
Bangladesh	[5]32,000	32,000	17,241	17,223	[5]33,000	33,000
Brunei	[e] 220,000	101,670	243,811	176,820	268,390	186,531
Burma [11]	12,000	5,400	[e] 11,000	[e] 4,900	[e] 9,700	5,600
China, People's Republic of [e]	1,100,000	950,000	1,400,000	1,200,000	1,600,000	1,400,000
India	59,124	32,242	67,733	25,320	81,576	35,244
Indonesia	[r] 177,667	28,425	202,423	[e] 40,000	222,227	82,224
Iran	1,698,691	701,678	1,766,721	787,360	1,603,384	771,057
Iraq	308,260	[9]42,731	329,237	[9]41,988	368,648	[9]58,410
Israel	[r] [5]1,907	[r] 1,907	[5]2,327	2,327	[5]2,105	2,105
Japan [6]	[e] 104,000	102,553	102,000	100,540	[e] 88,000	86,026
Kuwait [12]	581,065	186,045	466,939	186,894	382,367	183,792
Malaysia (Sarawak)	[e] 35,000	3,187	[e] 31,000	[e] 2,800	[e] 38,000	3,137
Oman [e]	90,000	1,500	90,000	1,500	105,000	1,700
Pakistan	[r] [5]155,383	[r] 155,383	[5]175,000	175,000	[5]164,101	164,101
Qatar	[r] 219,409	[r] [9]55,797	181,905	[9]45,909	192,005	[9]78,010
Saudi Arabia [12]	1,564,150	[e] 160,000	1,670,729	[e] 219,000	1,335,312	[e] 200,000
Syria	[e] 37,000	6,992	[e] 40,000	6,356	[e] 58,000	[e] 7,000
Taiwan	51,358	[e] 51,000	56,034	55,372	55,604	54,702
Turkey [e]	[r] 4,900	[r] 2,450	[r] 4,900	[r] 2,450	4,600	2,300
United Arab Emirates:						
Abu Dhabi	483,456	[r] [9]44,178	460,995	[9]42,377	432,002	[9]38,493
Dubai [e]	[r] 88,000	17,000	101,000	19,000	102,000	20,000
Sharjah [e]	--	--	9,000	([8])	15,000	([8])
Oceania:						
Australia	[5]144,754	144,754	[5]159,339	159,339	[5]177,477	177,477
New Zealand	9,339	[r] 9,323	10,647	10,594	[e] 11,500	11,442
Total	[r] 56,533,246	[r] 46,127,788	57,449,694	47,171,491	56,323,121	47,207,325

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, Thailand produces crude oil and presumably produces natural gas but available information is inadequate to estimate output levels.

[2] Comprises all marketed production (see footnote 3) plus gas vented, flared, reinjected for repressuring or for storage and used to drive gas turbines without being burned.

[3] Comprises all gas collected and utilized as a fuel or as a chemical industry raw material as well as that used for gas lift in fields, including gas used in oilfields and gasfields as a fuel by producers, even though it is not actually sold.

[4] Gas vented or flared is apparently not included; difference between gross production and marketed production is the amount reinjected into reservoirs.

[5] Gross production not reported, marketed output has been reported in lieu of estimating gross output because the quantity vented, flared or reinjected is believed to be small.

[6] Includes output from coal mines as follows, in million cubic feet: Austria: 1973—71, 1974—71, 1975—70 (estimate); Czechoslovakia: 1973—11,159, 1974—10,806, 1975—10,500 (estimate); West Germany: 1973—21,577, 1974—17,940, 1975—16,000 (estimate); the Netherlands: 1973—671, 1974 and 1975—0; Poland: 1973—7,628, 1974—7,451, 1975—7,400, (estimate); the United Kingdom: 1973—4,484, 1974—3,991, 1975—3,800 (estimate); Japan: 1973—10,806, 1974—9,747, 1975—9,500 (estimate).

[7] Total production is obtained from coal mines.

[8] No marketed production reported; there probably is some small field use in Denmark, Norway and Sharjah, and in Norway there was extraction of natural gas liquids reported in each year 1973–75, but available information is inadequate to permit reliable estimation of output levels.

[9] Includes gas reinjected to reservoirs, if any.

[10] Excludes gas used for gas lift.

[11] Data are for year ending June 30 of that stated.

[12] Includes ½ of production reported for the former Kuwait-Saudi Arabia Neutral Zone.

Natural Gas Liquids

By Thomas G. Clarke [1] and Leonard L. Fanelli [2]

Domestic production of natural gas liquids (NGL) from gas processing plants in 1975 was 596 million barrels, down 20.1 million barrels, or 3% from 1974 production. This was the third consecutive annual decline in NGL output. The value in 1975 fell to $2.77 billion from $3.09 billion in 1974. This represented a decrease in average unit value to $4.65 from $5.01 per barrel in 1974. This was a result of the Government's mandatory allocation program administered by the Federal Energy Administration (FEA). The establishment of new base prices by FEA early in 1975 resulted in a lower average unit value than in the previous year. On an individual basis, the base prices were adjusted to include product and nonproduct costs and shrinkage.

Total natural gas processed for liquids decreased 5% to 17.7 trillion cubic feet from 18.7 trillion cubic feet a year earlier. Decreased production of natural gas liquids during the year resulted from a decline in the availability of natural gas for processing. A mild winter season and an economic recession in 1975 contributed to an increase in yearend total NGL stocks to 124 million barrels compared with 114 million barrels in 1974.

Presidential Proclamation 4317, dated September 24, 1974, provided for the tariff on NGL imports (excluding propane) to increase to 18 cents per barrel from 15.5 cents per barrel, effective May 1, 1975. However, Presidential Proclamation 4341, dated January 23, 1975, established a tariff of 21 cents per barrel on NGL imports (excluding propane) effective February 1, 1975. No further change was made during the remainder of the year.

Natural gas liquids are products obtained from processing natural gas at natural gas processing plants. Products recovered are ethane, liquefied petroleum gases (LPG—butane, propane, pentane, and butane-propane mixtures), isobutane, and mixed gases. Other products are natural gasoline, plant condensate, and at plants equipped with fractionators, finished products such as gasoline, naphtha, jet fuel, kerosine, distillate fuel oil, and other products.

Data presented in this chapter were compiled from reports of plants that process natural gas. Plant condensate is included in NGL; field condensate is included with crude oil data found in the Petroleum chapter. Ethane and liquefied gases recovered from crude oil refinery operations (such as ethane, butane, and propane) are classed as liquefied refinery gases (LRG) and are reported as refined petroleum products.

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[1] Mineral specialist (Petroleum), Division of Petroleum and Natural Gas.
[2] Survey statistician, Division of Fuels Data.

Table 1.—Salient statistics of natural gas liquids in the United States
(Thousand barrels, unless otherwise noted)

	1971	1972	1973	1974	1975
Production:					
Ethane	80,524	100,691	108,220	117,791	122,945
LPG	337,110	344,045	338,813	330,155	321,141
Natural gasoline	159,732	156,450	155,880	144,129	130,065
Other [1]	40,449	37,030	31,510	24,023	21,807
Total production	617,815	638,216	634,423	616,098	595,958
Imports	38,976	63,829	85,276	r 77,335	67,699
Exports	9,391	11,469	9,927	9,032	9,432
Domestic demand	622,384	700,351	695,046	r 669,166	644,686
Average value at plant (dollars per barrel)	2.24	2.28	2.93	5.01	4.65
All stocks at plants, terminals and refineries	94,018	84,243	98,940	114,295	[2] 124,278

r Revised.
[1] Includes isopentane, plant condensate, finished gasoline, special naphtha, distillate fuel oil, kerosine, and miscellaneous.
[2] Includes 93,595 million barrels in underground storage.

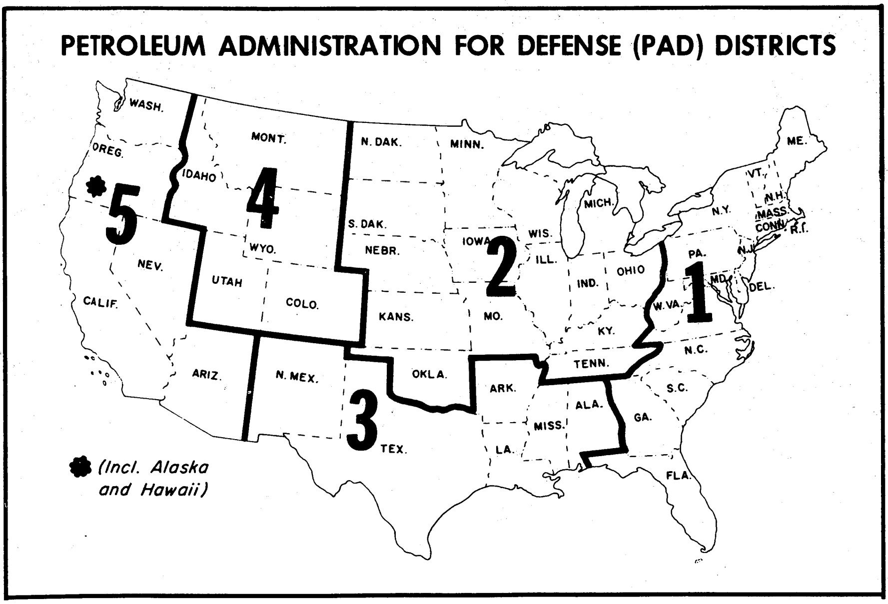

Figure 1.—Map of PAD districts.

DOMESTIC PRODUCTION

NGL production in 1975 was 596 million barrels, down 20.1 million barrels, or 3% from 1974 production. Output of all categories declined except ethane, which posted a 4.4% gain over that of 1974. Demand for ethane as a petrochemical feedstock, primarily for use in ethylene manufacture, caused NGL processors to take deeper cuts in gas throughput for increased ethane recovery. The following tabulation shows the quantity and percent change between 1974 and 1975 of major NGL groups:

	Thousand barrels	Percent
Ethane	+5,154	+4.4
LPG:		
Propane	−5,966	−2.9
Other	−3,034	−2.5
Natural gasoline and isopentane	−13,305	−9.0
Other natural gas liquids	−2,835	−13.6
Total	−20,140	−3.3

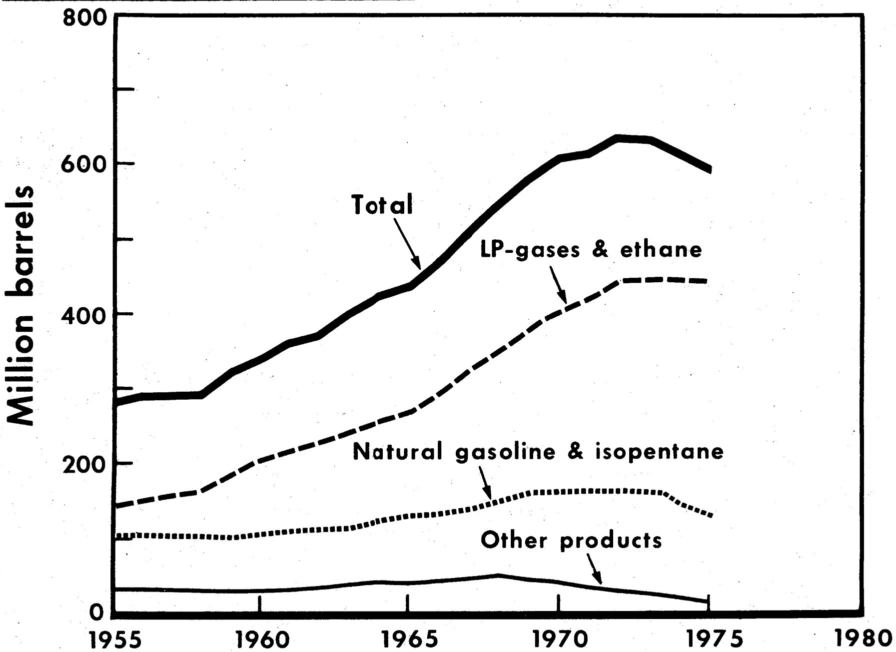

Figure 2.—Production of natural gas liquids in the United States.

Plant throughput capacity at yearend 1975 was 72.7 billion cubic feet of gas per day, down almost 2% from 73.9 billion cubic feet per day in 1974.[3] The number of gas processing plants in operation also declined by 9 to 754 at yearend 1975 as a result of the phaseout of processing plants in depleted field areas. These plants were located in 24 States and owned and/or operated by 130 companies. Production from gas processing plants was centered in Texas, 49%; Louisiana, 23%; Oklahoma, 7%; California and Alaska, 2%; New Mexico, 7%; and other, 12%.

RESERVES

The American Gas Association (AGA) estimated total proved reserves of natural gas liquids in the United States in 1975 at 6,268 million barrels. This was a decrease of 82.6 million barrels, or 1% from 1974. The decrease in 1975 was the eighth consecutive year of declining proved reserves. Approximately 56% of total reserve additions during the year were accounted for by revisions, 21% were discoveries, 19% were extensions, and 4% were new reservoirs in oilfields. Production to reserve ratio in 1975 was 8.6 to 1 compared with 8.8 to 1 in 1974.

Of total domestic natural gas liquid reserves, Texas accounted for 42%; Lou-

[3] Oil and Gas Journal. V. 74, No. 27, July 5, 1976, p. 67.

isiana, 27%; Kansas, 7%; New Mexico, 6%; and others, 68%. While total U.S. reserves decreased in 1975, Alabama and Colorado reported significant increases from 1974 reserve totals of 133.1 and 41.1 million barrels, respectively.

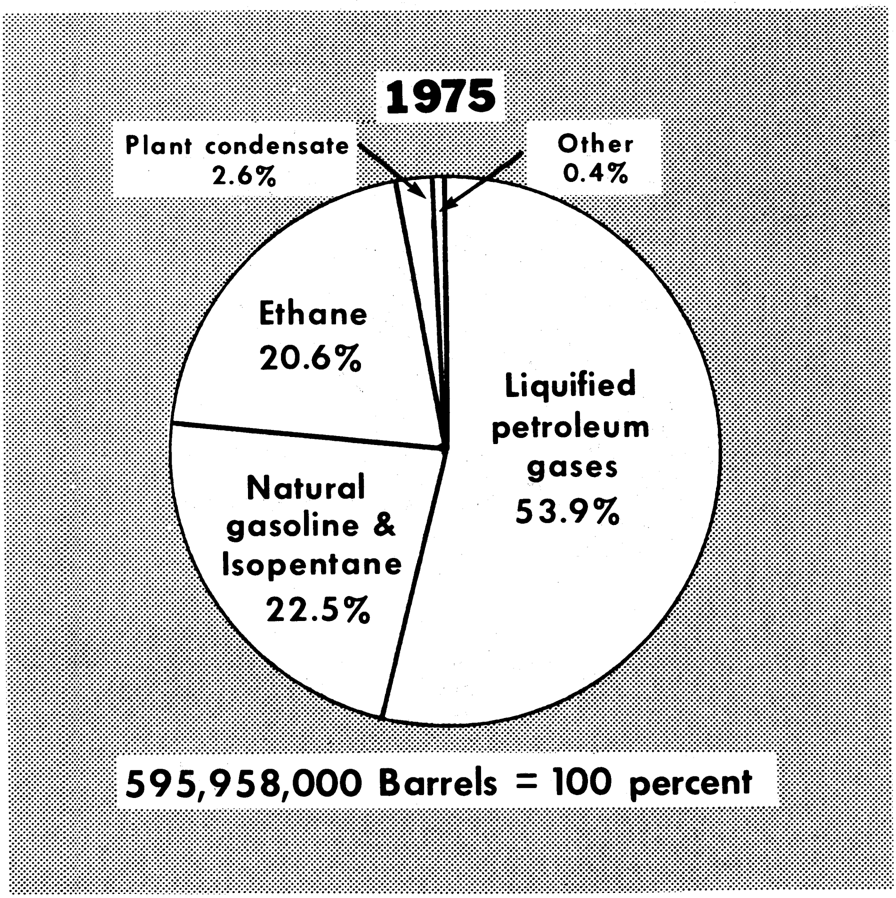

Figure 3.—Relative production of natural gas liquids components, 1975.

CONSUMPTION AND USES

In 1975, almost 44% of NGL output was used by refineries. Total input of liquids was 259.3 million barrels, a decrease of 5% compared with that in 1974. The decrease resulted primarily from a 9% drop in refinery input of natural gasoline and a 20% drop in plant condensate. Most other product categories posted minor gains. The following summary shows shipments (input) to refineries in thousand barrels:

	1974	1975	Change (percent)
Propane	3,465	3,926	+13.3
Butanes:			
Isobutane	30,829	35,760	+16.0
Normal butanes	29,110	35,056	+20.4
Other butanes	13,855	13,647	−1.5
Total butane	73,794	84,463	+14.5
Butane-propane mixtures	2,958	1,273	−57.0
Natural gasoline	147,603	134,087	−9.2
Isopentane	--	--	--
Plant condensate	44,596	35,570	−20.2
Grand total	272,416	259,319	−4.8

Domestic demand for liquefied gases and ethane at gas processing plants in 1975 was 375.5 million barrels, down from 387.7 million barrels in 1974. At refineries, demand for liquefied refinery gases (LRG) was 78.1 million barrels for fuel use and 32.8 million barrels for chemical use. Total domestic demand for LPG and LRG in 1975 was 486.4 million barrels compared with 512.8 million barrels in 1974.

Propane demand (including propylene), which accounts for 59% of total demand, was 285.9 million barrels in 1975 compared with 303.1 million barrels in 1974. Plant demand for propane during 1975 was 202.5 million barrels and refinery propane and propylene demand was 83.3 million barrels, 74% of which was for fuel use and the remainder was for chemical use. Domestic demand for butane (including butylene) decreased to 67.3 million barrels in 1975. Plant demand was 50.4 million barrels and refinery demand was 16.9 million barrels.

Domestic demand for ethane totaled 124.5 million barrels in 1975, about the same as in 1974. The output of ethane is utilized, almost in its entirety, as petrochemical feedstocks. Total production of ethylene from ethane in 1975 was 19.8 billion pounds, according to the U.S. International Trade Commission statistics. Production in 1974 was at an alltime high of 23.5 billion pounds.

Total sales of LPG and ethane were 24.6 billion gallons in 1975, down 2.7% from that in 1974. Propane constituted about 50.3% and ethane about 21.3% of the 1975 total. Approximately 38% of 1975 sales were to the chemical industry, 29% to residential and commercial users, and 15% for use in gasoline production.

STOCKS

Record levels of NGL and ethane stocks at yearend 1975 reflected a warmer than usual winter season across the United States. Total stocks reached a historic high of 140.3 million barrels on September 30, 1975. The total had decreased to 124.3 million barrels by December 31, up 8.7% from yearend 1974. These stocks included 93.6 million barrels in underground storage. Stocks at NGL plants and terminals at yearend 1975 were 118.2 million barrels, up 9.8 million barrels from that in 1974, whereas those at refineries were 6.1 million barrels, up only 146,000 barrels from 1974. The increase in stocks at NGL plants and terminals consisted principally of propane, 7.6 million barrels, and ethane, 2.5 million barrels; major reductions were in butane, 3 million barrels, and natural gasoline, 100,000 barrels.

PRICES AND VALUE

The average unit value of NGL production at natural gas processing plants in 1975 was $4.65 per barrel, down 36 cents, or 7% from the 1974 average. The total value of NGL production was $2.77 billion compared with $3.09 billion in 1974. This was a result of FEA mandatory allocation and price controls. The establishment of new base prices resulted in the lower 1975 average unit value. A tabulation of average prices, from 1971–75, in dollars per barrel, follows:

	1971	1972	1973	1974	1975
LPG and ethane	1.84	1.91	2.66	4.42	4.26
Natural gasoline and isopentane	3.00	3.06	3.51	6.59	5.81
Plant condensate	3.37	3.39	3.94	6.52	5.47
Finished gasoline and naphtha	4.34	4.66	4.29	7.97	7.76
Other [1]	2.62	2.58	3.25	5.39	5.35
Total	2.24	2.28	2.93	5.01	4.65

[1] Includes kerosine, distillate fuel oil, and miscellaneous products.

Yearend propane prices were higher than in 1974 because of the increased cost of natural gas as well as throughput costs. Propane price data for New York Harbor; Baton Rouge, La.; Oklahoma; Mt. Belview, Tex.; Wood River, Ill., and Los Angeles are presented in table 17.

FOREIGN TRADE

LP gases and plant condensate imports decreased 12.5% in 1975 to 67.7 million barrels from 77.3 million barrels in 1974. Lower demand for these imports was attributed to the recession in domestic economic activity and a warmer than usual winter season. Despite this decline, LPG and condensate imports ranked second, on a volume basis, in order of importance among liquid hydrocarbon product imports behind residual fuel oil. Plant condensate imports were delivered primarily for use as feedstocks in synthetic natural gas plants located in Ohio and Michigan.

Canada supplied all imports of plant condensate and 74% of the LPG imports. Venezuela and Saudi Arabia supplied 12% and 7% of LPG receipts, respectively. Other countries exporting more than 100,000 barrels per year to the United States were Kuwait, Algeria, and France. Total value of LPG imported in 1975 decreased to $354.9 million from $365.1 million in 1974.

Exports of LPG from the United States increased slightly to 9.4 million barrels. Traditionally, Mexico was the leading importer of U.S. LPG products, mostly butane-propane mixtures for consumption in residential heating and cooking. Mexico received 97% of total LPG exports, or 9.2 million barrels. Algeria received 2% or 166,000 barrels. Total value of exports increased to $100 million, up $5.6 million from 1974.

A breakdown of LPG exports by type was as follows: Butane, 6%; propane, 23%; and butane-propane mixtures, 71%.

WORLD REVIEW

The United States and Canada produced 69% of the total world production of NGL in 1975. Saudi Arabia, Kuwait, and Iran produced a combined estimated total of 82 million barrels, or about 8% of the total. Largest increases in production during the year were in these three Middle East countries.

The Government of Dubai, one of the Arab Emirates, finalized a venture with a Canadian firm, Sunningdale Oils, Ltd., for the construction of an NGL plant for processing of all gas produced in that country. Construction of the $200 million complex began in May. This plant's planned annual throughput of 36.5 billion cubic feet of gas will yield about 5.1 million barrels of liquids.

The Government of Kuwait awarded $60 million in contracts to four U.S. companies for the construction of seven turbine and compression stations for a NGL plant. The plant is scheduled for operation in December 1977 and is to have an annual capacity of 402 million barrels of LPG and natural gasoline.

The Oil Service Company of Iran has contracted with a U.S. firm to build a gas-processing plant in southern Iran at an estimated cost of $500 million. The plant, which is to include facilities for gas compression and processing, will be in the Ahwaz Marun oilfield. Operation of this plant is scheduled to begin in 1978 and the NGL output will be used as petrochemical feedstocks and fuel for consumption in Iran.

The Government of Saudi Arabia and the Arabian American Oil Co. (Aramco) have initiated construction of five NGL centers for the processing of associated gas from oilfield production. Each center is designed for a throughput of about 1.5 billion cubic feet of gas per day. The peak output of the center is expected to be about 554,000 barrels per day by 1979.

Offshore activity and increasing gas production in Australia's Bass Strait area have prompted the expansion of onshore NGL facilities. The capacity of a plant at Longford will be doubled to 670 million cubic feet of gas per day. In the Long Island Point fractionation plants at Westport, capacity will be increased from 43,500 barrels of propane-butane and 9,000 barrels of ethane per day to 58,800 and 12,500 barrels per day, respectively.

The Nigerian Government approved the construction of an LPG complex, designed to process 1 billion cubic feet per year of natural gas now being flared in the country's oilfields.

Construction of a gas treatment plant at Emden, West Germany, was nearing completion at yearend 1975. With an initial throughput capacity of 1 billion cubic feet of gas per day, the plant was scheduled to go onstream late in February 1976. The gas processed will come from the Ekofisk area of the Norwegian sector in the North Sea. Planned construction scheduled in 1977 will increase plant throughput capacity to 2.2 billion cubic feet of gas per day. This would be the largest capacity of any natural gas-processing plant in the world.

Construction continued on the world's first open sea offshore NGL plant located about 90 miles northeast of the city of Jakarta and 20 miles off the coast of Java. At the end of 1975, construction of the plant was about 75% complete. The complex will consist of seven offshore platforms in over 100 feet of water. Included are quarters for 150 men, 4 gas compression platforms, and 2 platforms for processing and stabilization of crude oil. Throughput of natural gas will be up to a rated capacity of 230 million cubic feet per day. The heavier NGL recovered will be added to the 125,000 barrels-per-day output of crude oil. The plant is scheduled to go onstream in mid-1976.

TECHNOLOGY

A new LPG recovery process has been developed for the extraction of high percentages of propane and heavier fractions from natural gas when the feedstock pressure (natural gas) is higher than 800 psi and the returned dry gas requires a similar pressure. The new absorption process allows separation without pressure reduction and subsequent repressuring for dry gas delivery. This results in considerable power conservation. Nearly 100% butane and 90% propane recovery can be economically achieved. The plant process can be used in remote locations because of its self-contained process cycle. About 2% to 3% of the methane is used as fuel. Propane is used as the cycle refrigerant and natural gasoline as the absorption oil.

The Warren Petroleum Inc., a subsidiary of Gulf Oil Corp., has developed a highly portable NGL extraction plant. Recovery from 0.1 to 10 million cubic feet per day throughput yields 65% to 75% of the propane and most all of the heavier components contained in the gas. For larger volumes of gas throughput, the processing plant is able to recover up to 76% of the ethane, 99% of the propane, and all of the heavier components. The plant is totally electric.

Computer control systems have become regular installations in all newly constructed domestic NGL plants. These systems control the process flow rates, provide an accurate analysis of product streams for quality control, enhance the recovery of liquids, and control precisely the processing variables.

Table 2.—Plant production, stocks at plants and terminals, and shipments from plants of natural gas processing plant products, in 1975

(Thousand barrels)

Product	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1975	Total 1974
Ethane:														
Production	10,634	9,438	10.448	9,860	10,231	9,732	10,246	10,227	9,736	10,703	10,614	11,076	122,945	117,791
Stocks	4,709	4,969	5,390	5,619	6,130	7,080	7,330	7,317	6,778	6,389	6,725	7,014	7,014	4,562
Shipments	10,487	9,178	10,027	9,631	9,720	8,782	9,996	10,240	10,275	11,092	10,278	10,787	120,493	118,252
Liquefied petroleum gases:														
Production	27,398	25,267	28,251	26,857	26,745	26,107	26,932	27,598	25,291	27,056	26,275	27,364	321,141	330,155
Stocks	88,391	84,160	82,487	86,514	94,530	104,360	110,685	116,771	120,879	120,116	117,588	105,557	105,557	97,956
Shipments	36,963	29,498	29,924	22,830	18,729	16,277	20,607	21,512	21,183	27,819	28,803	39,395	313,540	315,285
Isopentane:														
Production	317	287	332	280	340	288	312	379	290	304	298	332	3,759	3,794
Stocks	18	18	18	13	13	19	13	14	18	17	15	6	6	16
Shipments	315	287	332	285	340	282	318	378	286	305	300	341	3,769	3,810
Natural gasoline:														
Production	10,527	9,638	10,729	10,486	11,027	11,781	11,320	11,466	10,559	11,399	10,411	10,722	130,065	144,129
Stocks	5,138	4,892	4,646	4,340	4,402	5,016	4,634	4,591	4,447	4,624	4,773	4,897	4,897	5,202
Shipments	10,591	9,884	10,975	10,792	10,965	11,167	11,702	11,509	10,703	11,222	10,262	10,598	130,370	143,970
Plant condensate:														
Production	1,427	1,259	1,407	1,340	1,252	1,298	1,255	1,288	1,238	1,277	1,263	1,322	15,626	17,733
Stocks	460	518	444	432	509	511	447	505	512	494	531	617	617	507
Shipments	1,474	1,201	1,481	1,352	1,175	1,296	1,319	1,230	1,231	1,295	1,226	1,236	15,516	17,965
Motor gasoline:														
Production	73	80	86	84	86	79	83	70	80	79	74	85	959	1,084
Stocks	55	59	64	63	50	41	50	32	31	39	48	53	53	64
Shipments	82	76	81	85	99	88	74	88	81	71	65	80	970	1,103
Special naphthas:														
Production	12	12	12	12	12	11	10	9	8	9	9	9	125	175
Stocks	6	8	4	4	5	3	4	4	3	4	4	4	4	4
Shipments	10	10	16	12	11	13	9	9	9	8	9	9	125	178
Kerosine:														
Production	16	13	19	19	16	16	14	14	13	13	12	13	178	245
Stocks	16	14	15	17	16	15	17	18	15	14	15	15	15	17
Shipments	17	15	18	17	17	17	12	13	16	14	11	13	180	265
Distillate:														
Production	20	16	19	20	20	18	19	17	16	17	15	17	214	261
Stocks	37	38	38	43	43	42	42	41	44	47	49	46	46	39
Shipments	22	15	19	15	20	19	19	18	13	14	13	20	207	262
Miscellaneous products:														
Production	91	76	93	98	89	60	69	75	71	65	77	82	946	731
Stocks	13	7	5	5	5	6	44	5	6	4	7	5	5	10
Shipments	88	82	95	98	89	59	31	114	70	67	74	84	951	737
All products total:														
Production	50,515	46,086	51,396	49,056	49,818	49,390	50,260	51,143	47,302	50,922	49,048	51,022	595,958	616,098
Stocks	98,843	94,683	93,111	97,050	105,703	117,093	123,266	129,298	132,733	131,748	129,755	118,214	118,214	108,377
Shipments	60,049	50,246	52,968	45,117	41,165	38,000	44,087	43,111	45,867	51,907	51,041	62,563	586,121	601,827

Table 3.—Total production of products at natural gas processing plants, by State and month, in 1975
(Thousand barrels)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Arkansas	51	40	54	54	58	53	56	50	47	46	46	48	603
California	815	732	811	794	819	756	791	812	754	777	719	748	9,328
Colorado	481	455	484	513	575	525	532	562	573	638	598	627	6,563
Florida, Pennsylvania, West Virginia	769	704	767	715	1,063	1,076	1,415	1,268	1,192	1,337	1,334	1,337	12,977
Illinois and Kentucky	788	971	1,110	1,092	1,029	913	924	1,022	993	1,167	1,095	943	12,047
Kansas	2,728	2,494	2,636	2,418	2,432	2,248	2,430	3,003	2,182	2,327	2,350	2,610	29,858
Louisiana	11,757	10,847	12,042	11,239	11,905	11,168	11,310	11,333	10,174	11,190	10,993	11,564	135,522
Michigan	150	137	160	131	138	179	197	199	203	188	165	157	2,004
Mississippi and Alabama	71	63	87	77	74	74	75	78	68	77	60	71	875
Montana, Utah, and Alaska	319	298	323	325	332	335	337	350	354	344	309	822	3,948
Nebraska, North Dakota and South Dakota	167	142	159	143	157	158	165	168	166	166	160	159	1,910
New Mexico	3,303	3,031	3,438	3,353	3,338	2,954	3,246	3,368	3,309	3,423	3,340	3,305	39,408
Oklahoma	3,555	3,098	3,495	3,426	3,469	3,250	3,409	3,372	3,157	3,355	3,332	3,557	40,475
Texas	24,784	22,380	25,059	24,050	23,692	25,010	24,659	24,817	23,411	25,095	23,770	24,743	291,470
Wyoming	777	694	771	726	737	691	714	741	719	792	777	831	8,970
Total	50,515	46,086	51,396	49,056	49,818	49,390	50,260	51,143	47,302	50,922	49,048	51,022	595,958

Table 4.—Production of natural gas liquids at natural gas processing plants, and natural gas processed in the United States by State, in 1974–75

(Million cubic feet at 14.73 psia at 60° F unless otherwise stated)

State	Total natural gas liquids and ethane production (thousand barrels)	Natural gas processed
1974:		
Arkansas	617	19,784
California	10,804	252,402
Colorado	4,154	118,686
Florida, Pennsylvania, West Virginia	8,810	409,248
Illinois and Kentucky	12,628	342,046
Kansas	31,032	1,407,239
Louisiana	144,299	6,273,136
Michigan	1,315	45,106
Mississippi and Alabama	784	24,568
Montana, Utah, Alaska	4,018	146,907
Nebraska, North Dakota, South Dakota	2,032	34,243
New Mexico	39,984	1,060,491
Oklahoma	43,812	1,092,487
Texas	302,072	7,194,453
Wyoming	9,737	263,684
Total	616,098	18,684,480
1975:		
Arkansas	603	17,918
California	9,328	213,079
Colorado	6,563	136,090
Florida, Pennsylvania, West Virginia	12,977	765,597
Illinois and Kentucky	12,047	322,393
Kansas	29,858	1,367,949
Louisiana	135,522	5,831,487
Michigan	2,004	79,154
Mississippi and Alabama	875	29,694
Montana, Utah, Alaska	3,948	156,203
Nebraska, North Dakota, South Dakota	1,910	34,463
New Mexico	39,408	1,037,160
Oklahoma	40,475	1,033,003
Texas	291,470	6,509,132
Wyoming	8,970	215,104
Total	595,958	17,748,426

Table 5.—Natural gas liquids production and value at natural gas processing plants, by State and product, in 1975

State	LPG and ethane			Natural gasoline and isopentane			Plant condensate		
	Quantity (thousand barrels)	Value (thousands)	Dollars per barrel [1]	Quantity (thousand barrels)	Value (thousands)	Dollars per barrel [1]	Quantity (thousand barrels)	Value (thousands)	Dollars per barrel [1]
Arkansas	407	$2,377	$5.84	176	$1,251	$7.11	7	$48	$6.82
California	4,481	20,568	4.59	4,435	27,364	6.17	412	2,179	5.29
Colorado	4,821	22,803	4.73	1,730	9,290	5.37	12	88	7.31
Florida, Pennsylvania, West Virginia	11,420	52,573	4.60	1,557	9,313	5.98	--	--	--
Illinois and Kentucky	11,512	48,328	4.20	529	2,805	5.30	6	24	3.94
Kansas	23,563	71,632	3.04	6,289	25,030	3.98	4	25	6.13
Louisiana	103,714	392,039	3.78	28,181	159,223	5.65	3,040	16,264	5.35
Michigan	1,348	5,945	4.41	654	3,283	5.02	--	--	--
Mississippi and Alabama	560	3,313	5.92	303	1,818	6.00	--	--	--
Montana, Utah, Alaska	2,238	10,344	4.62	1,708	8,528	4.99	2	11	5.53
Nebraska, North Dakota, South Dakota	1,472	6,765	4.60	437	2,500	5.72	1	5	5.00
New Mexico	30,214	122,065	4.04	9,113	44,836	4.92	46	295	6.41
Oklahoma	29,640	140,197	4.73	10,094	58,444	5.79	601	4,261	7.09
Texas	212,635	965,363	4.54	65,926	407,423	6.18	11,278	61,127	5.42
Wyoming	6,061	29,578	4.88	2,692	16,529	6.14	217	1,165	5.37
Total	444,086	1,893,890	4.26	133,824	777,637	5.81	15,626	85,492	5.47

State	Finished gasoline and naphtha			Other products [2]			Total		
	Quantity (thousand barrels)	Value (thousands)	Dollars per barrel [1]	Quantity (thousand barrels)	Value (thousands)	Dollars per barrel [1]	Quantity (thousand barrels)	Value (thousands)	Dollars per barrel [1]
Arkansas	--	--	--	13	61	4.73	603	3,737	6.20
California	--	--	--	--	--	--	9,328	50,111	5.37
Colorado	--	--	--	--	--	--	6,563	32,181	4.90
Florida, Pennsylvania, West Virginia	--	--	--	--	--	--	12,977	61,886	4.77
Illinois and Kentucky	--	--	--	--	--	--	12,047	51,157	4.25
Kansas	--	--	--	2	7	3.50	29,858	96,694	3.24
Louisiana	229	1,614	7.05	358	1,829	5.11	135,522	570,969	4.21
Michigan	--	--	--	2	11	5.33	2,004	9,239	4.61
Mississippi and Alabama	--	--	--	12	58	4.83	875	5,189	5.93
Montana, Utah, Alaska	--	--	--	--	--	--	3,948	18,883	4.78
Nebraska, North Dakota, South Dakota	--	--	--	--	--	--	1,910	9,270	4.85
New Mexico	--	--	--	35	161	4.60	39,408	167,357	4.25
Oklahoma	--	--	--	140	678	4.84	40,475	203,580	5.03
Texas	855	6,797	7.95	776	4,353	5.61	291,470	1,445,063	4.96
Wyoming	--	--	--	--	--	--	8,970	47,272	5.27
Total	1,084	8,411	7.76	1,338	7,158	5.35	595,958	2,772,588	4.65

[1] Represents average unit value of sales throughout the year.
[2] Includes kerosine, distillate fuel oil, and miscellaneous products.

Source: Company reports and Bureau of Mines estimates.

Table 6.—Production of natural gas liquids and ethane at natural gas processing plants in the United States in 1975

(Thousand barrels)

PAD Districts and States	Ethane	Liquefied petroleum gases: Propane	Normal butane	Other butanes	Butane-propane mixture	Iso-butane	Total	Natural gasoline and iso-pentane	Plant con-densate	Finished gasoline and naphtha	All other products [1]	Total
District I	3,826	5,193	1,622	478	--	301	7,594	1,557	--	--	--	12,977
District II:												
Kansas	3,831	13,150	4,473	546	2	1,561	19,732	6,289	4	--	2	29,858
Michigan	--	581	270	--	173	324	1,348	654	--	--	2	2,004
Oklahoma	4,578	16,646	4,546	2,038	28	1,804	25,062	10,094	601	--	140	40,475
Other States [2]	6,609	4,493	1,453	36	--	393	6,375	966	7	--	--	13,957
Total District II	[2] 15,018	34,870	10,742	2,620	203	4,082	52,517	18,003	612	--	144	86,294
District III:												
Alabama and Mississippi	--	246	135	107	72	--	560	303	--	--	12	875
Arkansas	--	225	118	--	--	64	407	176	7	--	13	603
Louisiana:												
Gulf	36,389	38,851	12,247	447	16	11,268	62,829	26,970	2,441	--	281	128,910
Inland	889	1,964	872	82	86	603	3,607	1,211	599	229	77	6,612
Total Louisiana	37,278	40,815	13,119	529	102	11,871	66,436	28,181	3,040	229	358	135,522
New Mexico	4,919	14,838	4,849	3,736	63	1,809	25,295	9,113	46	--	35	39,408
Texas:												
East (field)	1,035	2,917	1,947	--	307	323	5,494	1,719	32	--	27	8,307
Gulf	14,831	16,498	5,919	444	504	4,480	27,845	11,155	1,387	187	106	55,511
Panhandle	1,395	13,557	2,903	7,228	1	1,678	25,367	11,931	30	--	319	39,042
West	22,572	40,191	8,396	7,633	152	2,952	59,324	21,970	2,535	--	9	106,410
Other	20,811	20,233	6,608	1,670	851	4,599	33,961	19,151	7,295	668	315	82,200
Total Texas	60,644	93,396	25,773	16,975	1,815	14,032	151,991	65,926	11,278	855	776	291,470
Total District III	102,841	149,520	43,994	21,347	2,052	27,776	244,689	103,699	14,371	1,084	1,194	467,878
District IV:												
Colorado	1,233	2,300	72	1,166	22	28	3,588	1,730	12	--	--	6,563
Montana and Utah	--	1,381	610	64	--	93	2,148	1,032	2	--	--	3,182
Wyoming	27	4,043	1,352	489	--	150	6,034	2,692	217	--	--	8,970
Total District IV	1,260	7,724	2,034	1,719	22	271	11,770	5,454	231	--	--	18,715
District V	--	3,266	411	51	396	447	4,571	5,111	412	--	--	10,094
Total United States	122,945	200,573	58,803	26,215	2,673	32,877	321,141	133,824	15,626	1,084	1,338	595,958

[1] Includes jet fuel, kerosine, distillate, and other.
[2] Other States includes Illinois, Kentucky, Nebraska, North Dakota, and South Dakota.

Table 7.—Production of natural gasoline by vapor pressure and PAD district in the United States, in 1975

(Thousand barrels)

Reid vapor pressure	District I	District II	District III	District IV	District V	Total
12 pounds and less	355	2,895	60,625	1,530	464	65,869
Over 12 pounds including 14 pounds	706	5,796	20,212	1,916	184	28,814
Over 14 pounds including 18 pounds	3	3,658	5,974	262	363	10,260
Over 18 pounds including 22 pounds	11	331	956	36	619	1,953
Over 22 pounds including 26 pounds	--	1,995	6,659	352	805	9,811
Over 26 pounds	482	2,613	6,333	1,254	2,676	13,358
Total	1,557	17,288	100,759	5,350	5,111	130,065

Table 8.—Comparison of 1974 and 1975 natural gas liquids production and value

	Thousand barrels		Change (percent)	Thousand dollars		Change (percent)	Dollars per barrel		Change (percent)
	1974	1975		1974	1975		1974	1975	
LPG and ethane	447,946	444,086	−0.9	1,980,769	1,893,890	−4.4	4.42	4.26	−3.6
Natural gasoline and isopentane	147,923	133,824	−9.5	974,825	777,637	−20.2	6.59	5.81	−11.8
Plant condensate	17,733	15,626	−11.9	115,632	85,492	−26.1	6.52	5.47	−16.1
Finished gasoline and naphtha	1,259	1,084	−13.9	10,028	8,411	−16.1	7.97	7.76	−2.6
Other products	1,237	1,338	+8.2	6,673	7,158	+7.3	5.39	5.35	−0.7
Total or average	616,098	595,958	−3.3	3,087,927	2,772,588	−10.2	5.01	4.65	−7.2

Table 9.—Estimated proved recoverable reserves of natural gas liquids in the United States, by State

(Thousand barrels)

State	Reserves as of Dec. 31, 1974	Changes in reserves				Reserves Dec. 31, 1975		
		Extensions	Revisions	New field discoveries	New reservoir discoveries	Nonassociated	Associated dissolved	Total reserves
Alabama	118,623	--	83,212	56,000	--	246,498	4,850	251,348
Alaska	845	--	2,496	--	--	--	2,521	2,521
Arkansas	4,748	--	−131	--	--	2,344	1,508	3,852
California [1]	98,232	660	17,991	--	50	2,329	105,173	107,502
Colorado	20,689	2,744	4,442	41,188	--	49,747	12,002	61,749
Florida		--	52,764	--	--	--	45,682	45,682
Kansas	394,419	5,825	44,406	976	202	406,360	10,669	417,029
Kentucky	44,676	900	−18	--	207	42,681	--	42,681
Louisiana [1]	1,882,381	30,693	−24,159	13,254	14,276	1,492,894	224,806	1,717,700
Michigan	20,264	--	−659	2,825	--	3,984	16,649	20,633
Mississippi	12,593	1,338	816	1,805	--	9,899	5,271	15,170
Montana	2,946	--	1,014	--	--	1,210	2,108	3,318
Nebraska	1,055	--	8	--	--	306	515	821
New Mexico	397,029	2,358	12,853	--	26	281,521	87,042	368,563
North Dakota	51,856	--	−79	--	--	--	50,011	50,011
Oklahoma	290,327	17,729	29,532	2,240	1,227	187,404	111,751	299,155
Pennsylvania	580	--	--	--	--	515	--	515
Texas [1]	2,796,988	46,535	122,880	9,605	12,024	1,194,499	1,466,169	2,660,668
Utah	52,354	1,604	−308	--	--	561	48,806	49,367
West Virginia	81,755	6,173	62	43	150	82,463	--	82,463
Wyoming	78,089	251	−1,626	100	--	34,913	32,169	67,082
Total United States	6,350,449	116,810	345,496	128,036	28,162	4,040,128	2,227,702	6,267,830
Gulf of Mexico	816,023	21,763	51,962	10,001	5,832	729,051	82,293	811,344

[1] Includes offshore.

Source: American Gas Association.

Table 10.—Natural gas liquids [1] used as refinery input in the United States, by Bureau of Mines refinery district and by month, in 1975
(Thousand barrels)

District	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
East coast	147	35	29	31	19	22	20	28	34	22	36	15	438
Appalachian	430	291	418	307	448	432	425	200	224	159	120	319	3,773
Indiana, Illinois, Kentucky, etc	3,167	2,541	2,621	1,562	1,820	2,556	2,599	2,403	2,322	2,543	2,659	3,291	30,084
Minnesota, Wisconsin, North Dakota, South Dakota	542	598	635	659	857	837	913	876	790	895	726	550	8,878
Oklahoma, Kansas, Missouri	2,437	1,796	1,761	1,914	1,891	1,875	2,017	2,028	1,914	2,379	2,331	2,353	24,696
Texas:													
Inland	1,801	1,625	1,707	1,752	1,834	1,713	1,948	1,804	1,878	1,823	1,792	1,954	21,631
Gulf coast	8,025	7,489	7,883	7,474	6,985	6,432	7,610	7,717	7,305	8,556	8,461	8,597	92,534
Total	9,826	9,114	9,590	9,226	8,819	8,145	9,558	9,521	9,183	10,379	10,253	10,551	114,165
Louisiana-Arkansas:													
Louisiana gulf coast	3,238	2,946	3,699	3,307	3,152	2,884	3,181	3,454	3,568	3,097	3,464	3,579	39,569
Arkansas and Louisiana inland	647	578	648	499	523	511	525	537	519	598	592	593	6,770
Total	3,885	3,524	4,347	3,806	3,675	3,395	3,706	3,991	4,087	3,695	4,056	4,172	46,339
New Mexico	111	123	99	89	125	117	131	136	127	137	148	136	1,479
Other Rocky Mountain	1,246	1,139	1,580	1,141	602	1,208	1,227	987	1,051	1,115	950	924	13,170
West coast	1,651	1,392	1,581	1,284	1,218	1,197	1,132	1,227	1,351	1,266	1,503	1,495	16,297
Total United States	23,442	20,553	22,661	20,019	19,474	19,784	21,728	21,397	21,083	22,590	22,782	23,806	259,319

[1] Comprises plant condensate (including imports), natural gasoline, LPG, and isopentane.

Table 11.—Production, stocks, and demand of liquefied gases and ethane at gas processing plants and refineries, in 1975
(Thousand barrels)

	Ethane	Propane	Butane	Butane-propane mixtures	Isobutane	Total
Production:						
At gas processing plants	122,945	200,573	85,018	2,673	32,877	444,086
At refineries:						
For fuel use	--	63,385	12,751	4,378	--	80,514
For chemical use	4,055	21,876	4,673	51	2,219	32,874
Total	127,000	285,834	102,442	7,102	35,096	557,474
Net change in stocks:						
Liquefied petroleum gases:						
At gas processing plants	2,452	11,311	6	−693	−3,023	10,053
At refineries	--	−5	113	−12	13	109
Liquefied refinery gases:						
For fuel use	--	1,843	506	6	--	2,355
For chemical use	--	88	8	−1	−6	89
Exports	--	4,852	4,636	--	--	9,488
Imports	--	22,058	18,669	--	--	40,727
Used at refineries	--	3,926	48,576	1,273	35,887	89,662
Domestic demand:						
At gas processing plants	120,493	202,547	50,356	2,105	--	375,501
At refineries:						
For fuel use	--	61,542	12,245	4,372	--	78,159
For chemical use	4,055	21,788	4,665	52	2,225	32,785
Total	124,548	285,877	67,266	6,529	2,225	486,445
Yearend stocks:						
Liquefied petroleum gases:						
At gas processing plants	7,014	76,024	20,998	872	7,663	112,571
At refineries	--	92	2,325	14	1,771	4,202
Liquefied refinery gases:						
For fuel use	--	5,527	2,520	65	--	8,112
For chemical use	--	200	47	--	16	263
Total	7,014	81,843	25,890	951	9,450	125,148

Table 12.—Sales of liquefied petroleum gases and ethane in the United States, 1971–75
(Thousand gallons)

	1971	1972	1973	1974	1975
For export	394,422	481,698	418,152	379,596	398,496
For use in gasoline production	3,347,190	3,578,106	3,369,282	3,369,114	3,765,804
For all other uses	19,183,542	21,833,700	22,199,048	21,538,692	20,430,690
United States total	22,925,154	25,893,504	25,986,482	25,287,402	24,594,990
By type:					
Ethane	3,685,248	4,460,442	5,016,606	5,232,444	5,231,016
Propane	12,313,449	13,847,948	13,494,198	13,158,599	12,371,980
Butane	2,060,143	2,404,659	2,710,600	2,415,333	2,156,944
Butane-propane mixtures	1,124,702	1,120,651	977,644	732,316	670,750
By principal use:					
Residential and commercial	7,668,413	8,253,340	7,345,991	7,231,035	7,019,989
Internal-combustion	1,324,126	1,479,190	1,409,302	1,309,750	1,162,396
Industrial [1]	908,965	1,124,263	1,094,898	1,069,319	1,016,103
Utility gas	209,778	302,481	344,436	356,848	402,752
Chemical [2]	8,809,319	10,358,858	10,977,239	10,654,038	9,403,057
Miscellaneous [3]	262,941	315,568	527,182	917,702	1,426,393

[1] Includes refinery fuel.
[2] Includes synthetic rubber.
[3] Includes secondary recovery of petroleum, agriculture uses, and use as synthetic natural gas feedstock.

Table 13.—Refinery input and stocks of natural gas plant products and refinery output and stocks of liquefied refinery gases, by product, in 1975 [1]

(Thousand barrels)

	PAD District																
	I			II					III						IV	V	
	East Coast	Appalachian #1	Total	Appalachian #2	Indiana, Illinois, etc.	Minnesota, Wisconsin, etc.	Oklahoma, Kansas, etc.	Total	Texas Inland	Texas Gulf	Louisiana Gulf	Arkansas, Louisiana Inland etc.	New Mexico	Total	Other Rocky Mt.	West Coast	United States
Natural gas plant products:																	
Refinery inputs:																	
Propane	1	--	1	--	--	--	--	--	--	541	3,282	--	--	3,823	20	82	3,926
Isobutane	--	29	29	557	5,806	1,119	5,545	13,027	4,569	5,732	8,687	716	229	19,933	932	1,839	35,760
Normal butane	91	--	91	236	7,600	935	4,421	13,192	1,222	6,541	9,954	159	113	17,989	316	3,468	35,056
Other butane	1	42	43	--	3,864	1,128	2,274	7,266	337	1,275	539	217	--	2,368	2,014	1,956	13,647
Butane-propane mix	--	--	--	--	48	--	--	48	6	631	52	--	181	870	353	2	1,273
Natural gasoline	214	--	214	--	4,922	3,085	11,896	19,903	15,397	71,170	16,055	2,159	841	105,622	2,132	6,216	134,087
Plant condensate	131	2,909	3,040	--	7,844	2,611	560	11,015	100	6,644	1,000	3,519	115	11,378	7,403	2,734	35,570
Total	438	2,980	3,418	793	30,084	8,878	24,696	64,451	21,631	92,534	39,569	6,770	1,479	161,983	13,170	16,297	259,319
Stocks at refineries: [1]																	
Propane	--	--	--	--	1	--	--	1	--	--	27	--	--	27	64	--	92
Isobutane	--	--	--	12	46	20	179	257	42	655	604	8	5	1,314	17	183	1,771
Normal butane	--	--	--	131	16	52	399	598	1	901	512	--	--	1,414	13	164	2,189
Other butane	--	12	12	--	--	28	29	57	7	8	--	2	--	17	50	--	136
Butane-propane mix	--	--	--	--	1	--	--	1	--	--	4	--	2	6	7	--	14
Natural gasoline	--	--	--	--	66	12	180	258	253	646	80	16	5	1,000	24	32	1,314
Plant condensate	--	73	73	--	156	12	--	168	--	135	--	21	1	157	140	10	548
Total	--	85	85	143	286	124	787	1,340	303	2,345	1,227	47	13	3,935	315	389	6,064

Liquefied refinery gases:																	
Refinery outputs:																	
Propane and/or propylene	12,503	614	13,117	377	17,637	1,826	6,338	26,178	2,886	21,027	9,245	698	268	34,124	1,446	10,396	85,261
Butane and/or butylene	1,874	259	2,133	--	513	151	249	913	595	5,593	3,043	341	170	9,742	435	4,201	17,424
Butane-propane mix	11	135	146	--	--	--	70	70	15	121	2,595	155	168	3,054	187	972	4,429
Isobutane	--	--	--	--	--	--	12	12	73	2,068	58	--	--	2,199	8	--	2,219
Total	14,388	1,008	15,396	377	18,150	1,977	6,669	27,173	3,569	28,809	14,941	1,194	606	49,119	2,076	15,569	109,333
Stocks at refineries: [1]																	
Propane and/or propylene	833	24	857	1	1,356	24	314	1,695	110	1,584	981	7	3	2,685	81	409	5,727
Butane and/or butylene	141	2	143	--	116	6	89	211	68	715	706	85	--	1,574	69	570	2,567
Butane-propane mix	--	--	--	--	--	--	4	4	--	4	1	2	6	13	6	42	65
Isobutane	--	--	--	--	--	--	7	7	--	8	--	--	--	8	1	--	16
Total	974	26	1,000	1	1,472	30	414	1,917	178	2,311	1,688	94	9	4,280	157	1,021	8,375

[1] Stocks as of December 31, 1975.

Table 14.—Refinery input of LPG, by product and PAD District

(Thousand barrels)

Items	PAD District I	II	III	IV	V	United States
1973						
Propane	--	435	2,278	7	35	2,755
Normal butane	148	7,419	14,864	385	3,174	25,990
Isobutane	38	12,171	20,877	965	1,672	35,723
Other butanes	89	6,345	1,839	1,804	1,190	11,267
Butane-propane mix	--	335	2,720	282	1,149	4,486
Total LPG	275	26,705	42,578	3,443	7,220	80,221
1974						
Propane	--	--	3,442	10	13	3,465
Normal butane	233	12,137	13,573	361	2,806	29,110
Isobutane	36	11,685	15,927	865	2,316	30,829
Other butanes	73	7,276	3,089	1,928	1,489	13,855
Butane-propane mix	34	61	1,932	443	488	2,958
Total LPG	376	31,159	37,963	3,607	7,112	80,217
1975						
Propane	1	--	3,823	20	82	3,926
Normal butane	91	13,192	17,989	316	3,468	35,056
Isobutane	29	13,027	19,933	932	1,839	35,760
Other butanes	43	7,266	2,368	2,014	1,956	13,647
Butane-propane mix	--	48	870	353	2	1,273
Total LPG	164	33,533	44,983	3,635	7,347	89,662

Table 15.—Liquefied refinery gases and ethane produced at refineries for fuel and chemical use in 1975

(Thousand barrels)

States and PAD districts	Ethane	Propane	Butane	Butane-propane mixture	Total
District I:					
New Jersey	40	4,952	1,275	--	6,267
Pennsylvania	--	5,221	477	--	5,698
Other States [1]	--	2,944	381	146	3,471
Total District I	40	13,117	2,133	146	15,436
District II:					
Illinois	--	9,735	102	--	9,837
Indiana	--	468	270	--	738
Kansas	352	3,263	106	2	3,723
Kentucky	--	896	--	--	896
Michigan	--	1,248	2	--	1,250
Ohio	--	5,492	139	--	5,631
Oklahoma	--	2,651	101	68	2,820
Other States [2]	--	2,425	205	--	2,630
Total District II	352	26,178	925	70	27,525
District III:					
Alabama and Mississippi	--	1,673	1,457	317	3,447
Arkansas	--	268	65	--	333
Louisiana:					
Gulf	634	7,875	1,644	2,343	12,496
Inland	--	127	276	90	493
Total Louisiana	634	8,002	1,920	2,433	12,989
New Mexico	--	268	170	168	606
Texas:					
Gulf	2,609	21,027	7,661	121	31,418
Inland	80	2,886	668	15	3,649
Total Texas	2,689	23,913	8,329	136	35,067
Total District III	3,323	34,124	11,941	3,054	52,442

See footnotes at end of table.

Table 15.—Liquefied refinery gases and ethane produced at refineries for fuel and chemical use in 1975—Continued

(Thousand barrels)

States and PAD districts	Ethane	Propane	Butane	Butane-propane mixture	Total
District IV:					
Colorado	--	88	106	53	247
Montana	--	724	49	24	797
Utah	--	399	50	32	481
Wyoming	--	235	238	78	551
Total District IV	--	1,446	443	187	2,076
District V	340	10,396	4,201	972	15,909
Total United States	4,055	85,261	[3]19,643	4,429	113,388

[1] Includes Delaware, New York, Virginia, and West Virginia.
[2] Includes Minnesota, Missouri, Nebraska, North Dakota, Tennessee, and Wisconsin.
[3] Includes 2,219,000 barrels of isobutane used for petrochemical feedstock.

Table 16.—Stocks of natural gas liquids and ethane in the United States

(Thousand barrels)

Date	LP gases and ethane		Natural gasoline and isopentane		Other finished products and plant condensate		Total at plants and terminals	Total at refineries	Grand total
	At plants and terminals	At refineries	At plants and terminals	At refineries	At plants and terminals	At refineries			
Dec. 31:									
1971	83,659	3,693	3,678	1,485	1,084	419	88,421	5,597	94,018
1972	74,859	3,077	3,384	1,418	995	510	79,238	5,005	84,243
1973	88,109	2,813	5,075	1,085	922	936	94,106	4,834	98,940
1974	102,518	4,093	5,218	1,262	641	563	108,377	5,918	114,295
1975:									
Jan. 31	93,100	4,374	5,156	1,528	587	655	98,843	6,557	105,400
Feb. 28	89,129	4,089	4,910	1,420	644	753	94,683	6,262	100,945
Mar. 31	87,877	4,054	4,664	1,332	570	671	93,111	6,057	99,168
Apr. 30	92,133	4,148	4,353	1,585	564	625	97,050	6,358	103,408
May 31	100,660	4,694	4,415	1,690	628	650	105,703	7,034	112,737
June 30	111,440	5,335	5,035	1,961	618	826	117,093	8,122	125,215
July 31	118,015	5,493	4,647	1,930	604	670	123,266	8,093	131,359
Aug. 31	124,088	5,535	4,605	1,768	605	473	129,298	7,776	137,074
Sept. 30	127,657	5,296	4,465	1,782	611	467	132,733	7,545	140,278
Oct. 31	126,505	5,255	4,641	1,418	602	560	131,748	7,233	138,981
Nov. 30	124,313	4,694	4,788	1,166	654	361	129,755	6,221	135,976
Dec. 31	112,571	4,202	4,903	1,314	740	548	118,214	6,064	[1]124,278

[1] Includes 93,595,000 barrels in underground storage.

Table 17.—Average monthly prices, liquefied petroleum gas (propane) in the United States
(Cents per gallon)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average for year
New York Harbor: [1]													
1972	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.95	9.18	9.18	9.18	8.71
1973	9.18	9.18	9.18	9.36	9.48	10.42	10.89	10.89	12.14	11.69	12.37	13.38	10.68
1974	17.75	20.81	18.24	18.24	18.24	19.57	20.89	20.35	15.74	15.80	17.74	17.74	18.43
1975	17.74	17.74	17.74	19.81	20.74	20.74	21.09	21.74	22.20	22.74	23.24	23.24	20.73
Baton Rouge, La.: [1]													
1972	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	6.12	6.21	6.21	6.21	5.88
1973	6.21	6.40	6.91	7.26	8.49	9.16	9.25	9.25	10.07	11.50	11.85	13.28	9.13
1974	16.57	16.12	13.50	13.48	13.48	16.67	19.28	19.02	15.64	15.67	16.64	16.64	16.06
1975	16.64	16.64	16.64	17.21	16.99	16.62	17.84	19.17	19.53	19.65	20.68	20.75	18.19
Oklahoma: [1]													
1972	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.25	5.60	5.67	5.67	5.67	5.38
1973	5.67	5.90	6.46	6.93	8.30	9.28	9.50	9.50	11.40	13.83	13.83	13.86	9.58
1974	16.36	16.34	13.71	13.59	13.59	16.55	18.54	16.94	13.29	13.00	13.00	13.50	14.87
1975	13.50	13.50	13.50	13.93	14.79	15.79	15.98	16.82	16.89	17.17	17.86	17.96	15.64
Mt. Belvieu, Tex.: [2]													
1972	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.93	6.02	6.02	6.02	5.71
1973	6.02	6.21	6.74	7.22	8.39	9.44	9.88	9.88	10.78	12.79	12.97	14.43	9.56
1974	16.67	16.31	14.48	14.48	14.48	16.49	18.59	17.25	16.33	16.00	15.85	15.85	16.06
1975	15.85	15.85	15.85	15.70	15.89	16.67	17.23	20.54	21.36	21.63	21.63	21.63	18.32
Wood River, Ill.:													
1972	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.45	6.88	6.96	6.96	6.96	6.61
1973	6.96	6.96	7.15	8.09	8.71	8.79	8.79	8.79	11.08	13.56	15.03	16.81	10.06
1974	18.23	17.84	16.34	16.34	16.34	16.34	17.31	17.34	17.34	17.34	17.34	17.34	17.12
1975	17.34	17.34	17.34	17.34	17.34	19.03	19.15	19.04	19.66	19.85	20.96	21.04	18.79
Los Angeles, Calif.:													
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	6.72	6.72	6.86	6.92	6.92	7.78	7.78	7.78	7.78	9.50	10.33	12.74	8.15
1974	13.33	13.98	15.95	15.95	15.95	17.08	17.95	17.95	17.95	17.95	17.95	17.95	16.66
1975	17.95	17.95	17.95	17.95	17.95	15.82	16.01	16.80	18.27	19.00	19.00	19.00	17.70

NA Not available.
[1] Producers' net contract price after discounts and summer-fill allowances in tank cars and transport trucks.
[2] For pipeline input, minimum 10,000 barrels.

Source: Platt's Oil Price Handbook and Oilmanac, 52d ed., 1976.

Table 18.—LPG [1] and plant condensate imported into the United States, by country
(Thousand barrels)

	1973	1974	1975
LPG:			
By country:			
Algeria	55	(2)	891
Angola	--	--	5
Australia	38	--	--
Belgium	97	--	4
Brunei	--	--	23
Canada	31,653	30,384	30,295
Chad	1	--	--
Chile	138	--	--
France	225	(2)	142
Gaza Strip	--	--	26
Hawaii Trade Zone	--	6	79
Indonesia	5	32	62
Iran	118	13	88
Kuwait	2	--	946
Liberia	54	--	--
Libya	594	--	--
Malaysia	131	24	--
Netherlands	237	276	--
Netherlands Antilles	235	575	27
Nigeria	--	55	71
Norway	103	--	--
Oman	32	16	31
Saudi Arabia	595	1,836	3,028
Singapore	1	35	40
United Arab Emirates	9	--	--
United Kingdom	856	84	4
Venezuela	12,622	11,634	4,965
Yemen	--	1	--
Total	47,801	44,971	40,727
By PAD district:			
District I	8,549	5,958	6,716
District II	18,417	19.304	17,894
District III	9,116	9,566	5,386
District IV	5,496	5,535	5,706
District V	6,223	4,608	5,025
Plant condensate:			
Canada	37,460	31,840	26,972
Venezuela	15	524	--
Total	37,475	32,364	26,972
Total LPG and plant condensate	85,276	r 77,335	67,699

r Revised.
1 Includes LRG.
2 Less than ½ unit.

Source: Imports of condensate as reported to the Bureau of Mines, other data are compiled from the U.S. Department of Commerce, Bureau of the Census.

Table 19.—LPG[1] exported from the United States, by country

Country	1974				1975			
	Butane (barrels)	Propane (barrels)	Butane propane mixtures (barrels)	Total (barrels)	Butane (barrels)	Propane (barrels)	Butane propane mixtures (barrels)	Total (barrels)
Algeria	--	--	--	--	165,560	326	--	165,886
Australia	--	274	214	488	5,580	309	784	6,673
Bahamas	19	661	--	680	--	1,289	--	1,289
Bahrain	--	--	2,374	2,374	--	--	472	472
Belgium-Luxembourg	--	537	--	537	--	280	639	919
Bermuda	257	--	417	674	--	--	206	206
Bolivia	--	--	--	--	--	931	--	931
Brazil	1	--	2,778	2,779	--	--	--	--
Canada	16,033	31,810	51,404	99,247	10,439	8,850	22,493	41,782
Denmark	431	--	46	477	--	341	--	341
French Pacific Islands	666	33	150	849	--	33	--	33
Germany, West	--	78	712	790	--	--	--	--
Guatemala	--	15,564	9,074	24,638	--	2,658	3,139	5,797
Israel	--	194	--	194	--	2,493	--	2,493
Italy	173	579	271	1,023	--	--	1	1
Jamaica	--	615	35	650	--	205	--	205
Japan	--	1,003	394	1,397	--	20	1,092	1,112
Mexico	112,925	2,291,557	6,481,674	8,886,156	351,483	2,125,590	6,710,782	9,187,855
Netherlands	--	215	1,351	1,566	--	447	--	447
Peru	--	--	--	--	--	21	3,154	3,175
South Africa, Republic of	--	--	93	93	--	2,401	--	2,401
Spain	375	--	--	375	--	9	--	9
Sweden	--	--	--	--	20	479	--	499
Switzerland	113	275	--	388	--	14	--	14
United Kingdom	573	1,288	32	1,893	--	17	216	233
Venezuela	217	181	1,123	1,521	--	428	696	1,124
Other	280	744	2,471	3,495	536	2,169	4,982	7,687
Total	132,063	2,345,608	6,554,613	9,032,284	533,618	2,149,310	6,748,656	9,431,584
Total value (thousands)	$1,328	$23,388	$69,748	r $94,464	$5,516	$22,291	$72,234	$100,041

r Revised.
1 Data include LRG.

Table 20.—Natural gas plant liquids: World production, by country
(Thousand 42-gallon barrels)

County [1]	1973 Propane	1973 Butane	1973 Subtotal	1973 Natural gasoline and other	1973 Total	1974 Propane	1974 Butane	1974 Subtotal	1974 Natural gasoline and other	1974 Total
North America:										
Canada	r 33,906	r 22,145	r 56,051	r 62,059	r 118,110	33,035	22,775	54,810	59,504	114,314
Mexico [2]	NA	NA	22,274	4,299	26,573	NA	NA	23,484	4,932	28,416
Trinidad and Tobago	--	--	--	79	79	--	--	--	48	48
United States	212,886	r 125,927	r 338,813	r 295,610	634,423	206,539	123,616	330,155	285,943	616,098
South America:										
Argentina	NA	NA	4,002	618	4,620	1,433	1,525	2,958	476	3,434
Bolivia	e 24	e 24	e 48	e 100	e 148	NA	NA	65	78	143
Brazil [2]	--	--	--	1,421	1,421	--	--	--	1,699	1,699
Chile [2]	1,811	1,161	2,972	2,075	5,047	1,834	1,203	3,037	1,962	4,999
Colombia	1,271	733	2,004	928	2,932	1,268	718	1,986	1,338	3,324
Ecuador	NA	NA	58	114	172	NA	NA	63	109	172
Peru	296	3	299	449	748	210	5	215	453	668
Venezuela [2]	NA	NA	23,382	10,487	33,869	NA	NA	21,521	9,075	30,596
Europe:										
Czechoslovakia	NA	NA	NA	19	19	NA	NA	NA	29	29
France	r 1,775	r 1,901	r 3,676	r 3,382	r 7,058	2,117	1,506	3,623	3,805	7,428
Germany, West	NA	NA	r 46	114	r 160	NA	NA	58	e 120	e 178
Hungary	NA	NA	951	418	1,369	NA	NA	1,009	751	1,760
Italy	--	--	--	539	539	--	--	--	615	615
Netherlands	--	--	--	608	608	--	--	--	e 1,300	e 1,300
Poland	NA	NA	46	314	360	NA	NA	46	390	436
Romania e	NA	NA	NA	3,900	3,900	NA	NA	NA	3,900	3,900
U.S.S.R. e 2	NA	NA	NA	NA	79,000	NA	NA	NA	NA	83,000
United Kingdom	NA	NA	NA	2,698	2,698	NA	NA	NA	3,059	3,059
Yugoslavia	NA	NA	524	228	752	NA	NA	577	129	706
Africa:										
Algeria [2]	NA	NA	766	11,305	12,071	NA	NA	696	11,400	12,096
Libya	520	2,240	2,760	9,900	12,660	335	1,888	2,223	4,119	6,342
Asia:										
Afghanistan	NA	NA	NA	NA	13	NA	NA	NA	NA	e 15
Brunei	146	34	180	1,673	1,853	155	31	186	2,514	2,700
Indonesia	NA	NA	10	33	43	NA	NA	e 12	e 38	e 50
Iran	5,256	5,000	10,256	5,132	15,388	NA	NA	12,760	4,465	17,225
Japan	NA	NA	151	44	195	NA	NA	172	41	213
Kuwait e	8,500	7,800	16,300	5,900	22,200	NA	NA	16,240	5,653	21,893
Pakistan e	NA	NA	NA	NA	70	NA	NA	NA	30	30
Saudi Arabia	NA	NA	25,628	9,822	35,450	NA	NA	37,758	11,638	49,396
Taiwan	428	304	732	201	933	381	258	639	194	833
Oceania:										
Australia	NA	NA	14,488	e 3,200	r e 17,688	NA	NA	e 14,000	e 3,300	e 17,300
New Zealand	5	4	9	NA	9	13	12	25	NA	25
Total [3]	r 266,824	r 167,276	r 526,426	r 437,669	r 1,043,178	247,320	153,537	528,318	423,107	1,034,440

See footnotes at end of table.

Table 20.—Natural gas plant liquids: World production, by country—Continued

(Thousand 42-gallon barrels)

County [1]	1975 [p]				
	Propane	Butane	Subtotal	Natural gasoline and other	Total
North America:					
Canada	34,282	22,411	56,643	55,463	112,106
Mexico [2]	NA	NA	28,897	5,768	32,665
Trinidad and Tobago	--	--	--	[e] 50	[e] 50
United States	200,573	120,568	321,141	274,817	595,958
South America:					
Argentina	1,539	1,687	3,226	472	3,698
Bolivia	NA	NA	144	86	230
Brazil [2]	--	--	--	1,931	1,931
Chile [2]	1,780	1,205	2,985	1,696	4,681
Colombia	2,811	734	3,545	1,324	4,869
Ecuador	NA	NA	53	139	192
Peru	NA	NA	NA	NA	664
Venezuela [2]	NA	NA	18,904	10,131	29,035
Europe:					
Czechoslovakia	NA	NA	NA	NA	[e] 30
France	1,644	1,770	3,414	4,500	7,914
Germany, West	NA	NA	[e] 50	[e] 110	[e] 160
Hungary	NA	NA	NA	NA	[e] 2,200
Italy	--	--	--	408	408
Netherlands	--	--	--	1,463	1,463
Poland	NA	NA	NA	NA	450
Romania [e]	NA	NA	NA	4,000	4,000
U.S.S.R. [e] [2]	NA	NA	NA	NA	90,000
United Kingdom	NA	NA	NA	NA	1,691
Yugoslavia	668	--	668	143	811
Africa:					
Algeria [2]	NA	NA	[e] 788	[e] 17,100	[e] 17,900
Libya	NA	NA	NA	NA	[e] 6,000
Asia:					
Afghanistan	NA	NA	NA	NA	[e] 15
Brunei	132	11	143	2,963	3,106
Indonesia	--	--	--	--	--
Iran	NA	NA	NA	NA	[e] 19,000
Japan	NA	NA	222	37	259
Kuwait [e]	NA	NA	NA	NA	[e] 15,000
Pakistan [e]	NA	NA	NA	33	33
Saudi Arabia	NA	NA	NA	NA	[e] 48,000
Taiwan	353	205	558	18	576
Oceania:					
Australia	NA	NA	NA	NA	[e] 18,500
New Zealand	NA	NA	NA	NA	[e] 27
Total [3]	243,732	148,591	441,381	382,652	1,023,622

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] In addition to the countries listed, the People's Republic of China may also produce natural gas liquids, but information is inadequate to make reliable estimates of output levels. Every effort has been made to include in this table only those natural gas liquids produced by natural gas processing plants, and to exclude natural gas liquids obtained from field treatment facilities including wellhead separators, because the latter are normally blended with crude oil and thus are in statistics on crude oil output. In some cases, however, sources do not clearly specify whether data presented represent only output of natural gas processing plants or if they include field output. Thus, some of the figures in this table may include field condensate. Where this appears to be the case, the country has been so footnoted, but it may also be true in the case of other countries.

[2] May include field condensate.

[3] Total of listed figures only, and as such represents an incomplete total, due to the fact that in the case of some countries, only the total of butane and propane or only total natural gas plant liquids are reported in sources, and insufficient data are available to estimate the distribution of the totals by individual type. Summation of totals of propane and butane thus does not equal the reported natural gas plant liquid total.

Nickel

By John D. Corrick [1]

The tight nickel supply that developed at yearend 1974 quickly changed into an oversupply situation in 1975 as the industrial economies of the world slowed down. The surplus nickel supply had little effect upon new developing nickel operations, although Falconbridge Nickel Mines, Ltd. (Falco), reduced their capacity by about 30% during the latter part of 1975. The supply base for nickel continued to expand with new mining and processing operations beginning in the Philippines, Australia, Botswana, and the United States.

Domestic nickel consumption decreased in 1975 by nearly 30% from the record high consumption in 1974 and resulted in record high inventories of consumer-held nickel during 1975. The surplus supply situation was compounded by decreased demand for nickel and the simultaneous startup of several new nickel operations worldwide. Nevertheless, the surplus could have been more pronounced had it not been for startup troubles at most of the new operations. The pattern of nickel consumption was little changed from previous years. For the first time in several years ferronickel failed to increase its share of the total primary nickel consumed in the United States.

The price of cathode nickel was increased 19 cents per pound on August 29 by International Nickel Co. of Canada, Ltd. (INCO). Similar price increases were made in domestic and foreign produced ferronickel in September. Consumer price protection, at the old prices, was in effect until December.

World trade in nickel was set back by the general slowdown in industrial economies. Imports of nickel into the United States in 1975 were down nearly 27% when compared with those in 1974. Japanese importers of nickel requested reductions in nickel ore import quotas agreed upon in 1974 from New Caledonia and Indonesia because of a slack demand for stainless steel.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient nickel statistics
(Short tons)

	1971	1972	1973	1974	1975
United States:					
Mine production [1]	17,036	16,864	18,272	16,618	16,987
Plant production:					
Primary	15,654	15,731	13,895	14,093	14,343
Secondary	26,836	35,926	32,629	20,930	17,880
Exports (gross weight)	26,143	21,671	22,070	30,442	30,121
Imports for consumption	142,183	173,978	190,418	220,655	160,507
Consumption	128,802	159,286	197,723	208,409	146,495
Stocks, Dec. 31: Consumer	16,005	26,260	28,759	r 45,291	34,936
Price cents per pound	133	133–153	153	153–201	201–220
World: Mine production	702,027	673,817	r 782,588	r 870,742	900,329

r Revised.
[1] Mine shipments.

DOMESTIC PRODUCTION

The level of activity by domestic nickel producers increased in 1975 over that of 1974 as a result of the startup of the AMAX Inc. renovated nickel-copper-cobalt refinery in Louisiana, although the refinery operated well below capacity. According to the AMAX annual report the refinery produced 8,000 short tons of nickel during the first year of operation.[2] The one domestic nickel mine, operated by Hanna Mining Co. at Riddle, Oreg., produced 16,987 tons of nickel from laterite ore, as measured by mine shipments. Nickel recovered at the Hanna smelter and byproduct nickel salts and metals produced at copper and other metal refineries amounted to 14,343 tons; part of the byproduct originated from scrap. Exploration for nickel in 1975 continued in Minnesota, Oregon, California, and Montana. Major exploration interest was centered in Minnesota. The two principal firms interested in developing nickel mining in Minnesota were INCO and AMAX (Minnamax). At yearend, officials of INCO announced that they would suspend further activity on their nickel-copper mining project near Ely, Minn. The proposed changes in State policy toward nickel-copper development were the reasons given for suspension of work. On the other hand, AMAX Exploration Inc. requested and received permission to develop a test mine shaft near Babbitt, Minn. AMAX began construction of surface facilities required for the underground exploration phase in November. The test shaft will be 14 feet in diameter and 1,710 feet deep. AMAX hoped to obtain a 5,000-ton bulk sample of ore for metallurgical testing. Universal Oil Products Co. (UOP) announced plans to construct a $2 million demonstration plant at Tucson, Ariz. Construction was to begin in the fall of 1975. The plant will test UOP's new hydrometallurgical process for treating lateritic ores. Designed throughput of the plant was to be 5 tons per day of ore resulting in the production of 150 pounds per day of high-purity nickel.

UOP officials held discussions with Puerto Rican officials during 1975 on the possibility of the company developing nickel deposits near Guanajibo, Puerto Rico. Puerto Rican ore reserves have been estimated at 375,000 tons of contained nickel, sufficient to support a 30-million-pound-per-year operation for 25 years. Puerto Rican laterites have been tested by UOP on a laboratory scale and would probably be one of the first ores to be tested in the new pilot plant.

[2] AMAX Inc. 1975 Annual Report. P. 6.

Table 2.—Primary nickel produced in the United States
(Short tons, nickel content)

	1971	1972	1973	1974	1975
Byproduct of metal refining	2,581	2,505	958	873	[1]14,343
Domestic ore	13,073	13,226	12,937	13,220	

[1] Combined to conceal individual company confidential data.

Table 3.—Nickel recovered from nonferrous scrap processed in the United States, by kind of scrap and form of recovery
(Short tons)

Kind of scrap	1974	1975	Form of recovery	1974	1975
New scrap:			As metal	1,230	1,979
Nickel-base	1,054	3,123	In nickel-base alloys	1,272	2,623
Copper-base	4,224	5,222	In copper-base alloys	7,400	7,032
Aluminum-base	627	1,251	In aluminum-base alloys	980	1,318
			In ferrous and high-temperature alloys [1]	10,015	4,205
Total	5,905	9,596	In chemical compounds	33	723
Old scrap:					
Nickel-base	14,040	7,825	Total	20,930	17,880
Copper-base	598	375			
Aluminum-base	387	84			
Total	15,025	8,284			
Grand total	20,930	17,880			

[1] Includes only nonferrous nickel scrap added to ferrous high-temperature alloys.

CONSUMPTION AND USES

Pure unwrought nickel increased its share of the total U.S. nickel market in 1975 at the expense of ferronickel and nickel oxide. Pure nickel accounted for 68% of the total nickel consumed in 1975 compared with 59% in 1974 and 62% in 1973. Most of the pure nickel was consumed in the production of nickel wrought products and nickel alloys and electroplating. Ferronickel accounted for 17% of the total nickel consumed in 1975 compared with 22% in 1974 and 18% in 1973. Principal consumption of ferronickel was in stainless and alloy steels.

The pattern of nickel consumption in 1975 was as follows: 26% in stainless and heat resisting steel; 25% in other nickel and nickel alloys; 13% in electroplating; 14% in alloy steel; and 6% in nickel-copper and copper-nickel alloys.

A combination of reduced nickel consumption, a continued high level of imports, and the possibility of future price increases resulted in consumer stocks of nickel reaching high levels in 1975. Consumer-held stocks of nickel were being worked off at yearend. The surplus supply situation was compounded by the simultaneous startup of Marinduque Mining & Industrial Corp.'s mine and smelter in the Philippines, Freeport Queensland Nickel Inc.'s mine and treatment plant in Australia, AMAX Nickel Division's rehabilitated refinery in Louisiana, and production from a mine and smelter located in Botswana.

Table 4.—Stocks and consumption of new and old nickel scrap in the United States in 1975

(Gross weight, short tons)

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New	Old	Total	
Smelters and refiners:						
Nickel and nickel alloys	1,669	471	616	1,438	2,054	86
Monel metal	412	1,061	555	658	1,213	260
Nickel silver [1]	752	2,397	297	2,153	2,450	699
Cupronickel [1]	79	347	--	336	336	90
Nickel residues	2,268	4,757	6,991	--	6,991	34
Total	4,349	6,289	8,162	2,096	10,258	380
Foundries and other manufacturers:						
Nickel and nickel alloys	4,489	7,357	--	8,063	8,063	3,783
Monel metal	16	356	--	359	359	13
Nickel silver [1]	5,635	13,255	15,785	10	15,795	3,095
Cupronickel [1]	1,475	20,931	20,573	--	20,573	1,833
Nickel residues	90	420	364	30	394	116
Total	4,595	8,133	364	8,452	8,816	3,912
Grand total:						
Nickel and nickel alloys	6,158	7,828	616	9,501	10,117	3,869
Monel metal	428	1,417	555	1,017	1,572	273
Nickel silver [1]	6,387	15,652	16,082	2,163	18,245	3,794
Cupronickel [1]	1,554	21,278	20,573	336	20,909	1,923
Nickel residues	2,358	5,177	7,355	30	7,385	150
Total	8,944	14,422	8,526	10,548	19,074	4,292

[1] Excluded from totals because it is copper-base scrap, although containing considerable nickel.

Table 5.—Nickel (exclusive of scrap) consumed in the United States, by form

(Short tons)

Form	1971	1972	1973	1974	1975
Metal	95,639	110,422	121,821	123,996	99,693
Ferronickel	11,515	22,806	36,371	45,661	25,325
Oxide powder and oxide sinter	16,554	19,315	33,257	33,617	16,630
Salts [1]	2,376	3,939	3,668	2,026	1,751
Other	2,718	2,804	2,606	3,109	3,096
Total	128,802	159,286	197,723	208,409	146,495

[1] Metallic nickel salts consumed by plating industry are estimated.

Table 6.—U.S. consumption of nickel (exclusive of scrap) in 1975, by use and form
(Short tons)

Use	Commercially pure unwrought nickel	Ferronickel	Nickel oxide	Nickel sulfate and other nickel salts	Other forms	Total of figures shown
Steel:						
Stainless and heat-resisting	12,060	17,255	8,593	--	264	38,172
Alloys (excludes stainless)	7,017	6,662	5,761	--	885	20,325
Superalloys	6,682	186	20	--	142	7,030
Nickel-copper and copper-nickel alloys	9,343	1	21	19	51	9,435
Permanent magnet alloys	2,763	450	55	--	--	3,268
Other nickel and nickel alloys	35,602	257	1,105	3	226	37,193
Cast irons	2,357	509	423	--	1,122	4,411
Electroplating [1]	17,803	--	39	1,337	1	19,180
Chemicals and chemical uses	1,731	--	419	249	35	2,434
Other uses [2]	4,335	5	194	143	370	5,047
Total reported by companies canvassed and estimated	99,693	25,325	16,630	1,751	3,096	146,495

[1] Based on monthly estimated sales to platers.
[2] Includes batteries, ceramics, and other alloys containing nickel.

Table 7.—Nickel (exclusive of scrap) in consumer stocks in the United States, by form
(Short tons)

Form	1973	1974 [r]	1975 [p]
Metal	11,858	25,862	19,233
Ferronickel	7,735	11,511	11,267
Oxide powder and oxide sinter	8,018	6,189	3,275
Salts	466	457	435
Other	682	1,272	726
Total	28,759	45,291	34,936

[p] Preliminary.
[r] Revised.

Table 8.—Consumption, stocks, receipts, shipments and/or sales of secondary nickel in 1975 by use
(Short tons)

Use	Receipts	Consumption	Shipments or sales	Stocks, end of year
Steel (stainless and heat-resisting and alloy)	24,695	43,994	1,465	4,426
Nonferrous alloys (super, nickel-copper and copper-nickel, permanent magnet and other nickel)	3,980	4,057	8	523
Foundry (cast irons)	477	472	--	8
Chemicals (catalysts, ceramics, plating salts and other chemical uses)	5	2	2	3
Total reported by companies canvassed and estimated	29,157	48,525	1,475	4,960

PRICES

The producer's price for electrolytic nickel was increased by INCO on August 29 from $2.01 per pound to $2.20 per pound. Nevertheless, INCO extended price protection at the old price of $2.01 per pound to all prior nickel customers until December 1.

The price of domestically produced ferronickel was increased on September 16 from $1.97 per pound of contained nickel to $2.16 per pound of contained nickel. Société Métallurgique Le Nickel increased the price of its nickel products on September 9. The new prices were as follows: FN4, $2.20 per pound of nickel content; FN3, $2.25 per pound of nickel content; FN1, $2.29 per pound of nickel content; FNC, $2.23 per pound of nickel content; and nickel rondelles, $2.26 per pound.

FOREIGN TRADE

The gross weight of U.S. exports of nickel, nickel alloys, and nickel catalysts (excluding scrap) was 4% less in 1975 than that exported in 1974. Exports of unwrought nickel in 1975 increased 110% over those exported in 1974.

Canada continued to be the principal supplier of nickel to the United States in 1975 and accounted for 62% of the total nickel imports for consumption. Canada's portion of the total imports was 4% higher than in 1974. New Caledonia replaced Norway as the second most important source of imported nickel and accounted for 11% of the total nickel imported. Norway, the Dominican Republic, and Australia completed the top five countries supplying nickel to the United States. These five countries accounted for 88% of the total nickel imported in 1975. Imports of ferronickel decreased from 15% of total primary nickel imports in 1974 to 13% in 1975, while unwrought nickel increased from 62% in 1974 to 67% in 1975. The total of all forms of primary nickel imported for consumption in 1975 was 27% less than that imported in 1974.

Table 9.—U.S. exports of nickel and nickel alloy products, by class

Class	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Unwrought	3,764	$10,549	3,174	$11,522	6,676	$25,281
Bars, rods, angles, shapes and sections	1,949	9,647	3,852	21,290	3,400	22,132
Plates, sheets, and strip	3,827	20,470	8,524	49,857	5,808	44,402
Anodes	752	2,400	543	2,066	275	940
Wire	697	3,818	1,117	6,056	679	4,769
Powder and flakes	514	4,813	571	6,037	429	4,575
Foil	11	61	19	56	26	54
Catalysts	2,478	6,584	3,477	9,143	3,536	13,713
Tubes, pipes, blanks, and fittings therefore, and hollow bars	1,825	9,815	2,903	17,226	2,333	15,791
Waste and scrap	6,253	7,646	6,262	10,245	6,959	9,645
Total	22,070	75,803	30,442	133,498	30,121	141,302

Table 10.—U.S. imports for consumption of nickel products, by class

Class	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Ore	8,207	$190	62	$2	1,135	$47
Unwrought	120,083	343,494	137,314	450,342	107,084	406,894
Oxide and oxide sinter	6,301	13,466	6,449	15,081	5,063	15,172
Slurry [1]	38,749	81,851	42,999	96,959	23,991	63,522
Bars, plates, sheets, and anodes	267	1,164	342	1,665	512	3,272
Rods and wire	790	3,959	696	3,722	960	5,804
Shapes, sections and angles	1	6	7	46	10	81
Pipes, tubes and fittings	570	2,579	r 339	r 2,066	265	1,961
Powder	7,196	22,770	9,316	33,344	9,749	39,328
Flakes	95	297	55	201	23	85
Waste and scrap	2,642	3,906	3,699	8,545	2,353	5,864
Ferronickel	89,780	70,532	102,430	87,255	65,046	67,813
Total (gross weight)	274,681	544,214	r 303,708	r 699,228	216,191	609,843
Nickel content [2]	190,418	XX	220,655	XX	160,507	XX

r Revised. XX Not applicable.
[1] Nickel-containing material in slurry, or any form derived from ore by chemical, physical, or any other means, and requiring further processing to recover nickel or other metals.
[2] Estimated from gross weight of primary nickel products.

Table 11.—U.S. imports for consumption of new nickel products,[1] by country

(Short tons)

Country	Metal		Powder and flakes		Oxide and oxide sinter		Slurry and other [2]			
	1974	1975	1974	1975	1974	1975	1974		1975	
	(gross weight)		(gross weight)		(gross weight)		Gross weight	Nickel content	Gross weight	Nickel content
Australia	3,427	2,844	r 1,853	1,819	--	1,032	--	--	155	141
Canada	90,476	79,984	r 4,218	4,533	6,372	3,939	35,468	27,956	15,550	11,789
Dominican Republic	180	16	--	--	--	--	--	--	--	--
Finland	365	775	--	--	--	--	--	--	--	--
France	70	42	--	--	51	20	--	--	--	--
French Pacific Islands	--	--	--	--	--	--	7,419	5,647	8,167	6,213
Germany, West	214	34	--	(3)	--	20	--	--	--	--
Japan	225	251	--	--	3	30	9	1	--	--
Netherlands	315	61	--	36	(3)	(3)	--	--	--	--
Norway	16,512	11,180	59	165	--	--	--	--	--	--
Philippines	--	3,019	--	1,540	--	--	--	--	--	--
Rhodesia, Southern	1,902	2,766	--	--	--	--	--	--	--	--
South Africa, Republic of	3,741	3,173	254	606	--	--	--	--	--	--
Switzerland	62	--	25	--	--	--	--	--	--	--
U.S.S.R	11,055	2,467	--	--	--	--	--	--	--	--
United Kingdom	8,569	400	2,953	1,073	2	2	59	49	119	57
Other	201	72	9	--	21	20	44	7	--	--
Total	137,314	107,084	9,371	9,772	6,449	5,063	42,999	33,660	23,991	18,200

r Revised.

[1] Ore: All from French Islands, 1974, 62 short tons; 1975, 1,135 short tons.

[2] Nickel-containing material in slurry, or in any form derived from ore by chemical, physical, or any other means, and requiring further processing to recover nickel or other metals.

[3] Less than ½ unit.

WORLD REVIEW

Australia.—Near yearend 1975, the Australian Government appeared to be softening its stand on foreign equity participation as it related to control of the mining industry in that country. The basic requirement was that foreign investment in the development of raw materials be limited to no more than 50% of the equity and that no more than 50% of the votes on the board of directors be foreign. The Prime Minister stated that the regulations should serve as guidelines instead of constituting inflexible rules. He also emphasized that each investment proposal would be considered on a case-by-case basis. Also, it would not be mandatory for foreign exploration companies to seek Australian participation at the outset of initial exploration programs.[3]

Western Mining Corp., Ltd., had a capacity to produce 42,000 tons of nickel per year in 1975. Expansion plans underway in 1975 would raise this capacity to 71,500 tons and make Western Mining about equal to Société Métallurgique Le Nickel's (SLN) New Caledonian operation and approach the capacity of Falco. The cost of the expansion was reported to be $36 million. At the Kalgoorie smelter new

[3] Iron Age. Australian Lame Duck? V. 216, No. 17, Oct. 27, 1975, p. 97.

Table 12.—Nickel: World mine production [1] by country
(Short tons)

Country	1973	1974	1975 p
Albania e	6,600	6,600	6,600
Australia (content of concentrate)	r 44,748	47,570	82,242
Botswana	600	13,042	18,314
Brazil (content of ore)	4,544	2,875	2,900
Burma (content of speiss)	23	24	21
Canada [2]	r 268,908	296,600	269,826
Cuba (content of oxide and sulfide) e	r 40,200	40,200	40,300
Dominican Republic	33,200	34,400	34,400
Finland:			
Content of concentrate	6,371	6,352	5,957
Content of nickel sulfate	243	205	228
Germany, East e	2,200	2,400	2,400
Greece (recoverable content of ore) [3]	28,940	31,440	31,014
Indonesia (content of ore) [3]	22,946	23,250	e 23,000
Mexico (content of ore)	35	28	55
Morocco (content of nickel ore and cobalt ore)	330	550	550
New Caledonia (recoverable) [4]	r 118,363	148,333	146,767
Norway (content of concentrate)	512	635	391
Philippines	440	359	e 13,200
Poland (content of ore) e	1,700	2,200	2,200
Rhodesia, Southern (content of concentrate)	13,000	12,700	12,100
South Africa, Republic of	21,413	24,361	22,877
U.S.S.R. (content of ore) e	r 149,000	r 160,000	168,000
United States (content of ore shipped)	18,272	16,618	16,987
Total	r 782,588	870,742	900,329

e Estimate. p Preliminary. r Revised.

[1] Insofar as possible, this table represents mine production of nickel; where data relate to some more highly processed form, the figures given have been used in lieu of unreported actual mine output to provide some indication of the magnitude of mine output, and are so noted, parenthetically, following the country name.

[2] Refined nickel and nickel content of oxides and salts produced, plus recoverable nickel in exported matte and speiss.

[3] Includes a small amount of cobalt not reported separately.

[4] Nickel-cobalt content of metallurgical plant products, plus recoverable nickel-cobalt in exported ores.

Table 13.—Nickel: World smelter production,[1] by country
(Short tons)

Country [2]	1973	1974	1975 p
Australia	r 22,000	22,000	22,000
Botswana	--	2,899	7,099
Brazil [3]	3,000	2,636	2,600
Canada [3]	r 179,125	206,793	164,024
Cuba e	20,000	20,000	20,000
Czechoslovakia e	900	900	900
Dominican Republic [4]	33,200	34,400	34,400
Finland	6,436	7,115	7,214
France	12,000	9,400	9,900
Germany, East e	2,200	2,400	2,600
Germany, West	r 138	161	e 140
Greece	r 15,373	16,600	16,343
Japan	r 100,000	115,300	87,000
New Caledonia [5]	r 63,091	74,262	78,338
Norway	r 47,085	47,646	40,847
Philippines	--	--	10,322
Poland e	1,700	r 2,200	2,200
Rhodesia, Southern e	11,000	11,000	11,000
South Africa, Republic of	16,500	18,700	19,000
United Kingdom	40,600	39,400	42,800
U.S.S.R. e	r 142,000	r 148,000	148,000
United States:			
Byproduct of metal refining	958	873	[6] 14,343
Recovery from domestic ore	12,937	13,220	
Total	r 730,243	795,905	741,070

e Estimate. p Preliminary. r Revised.
[1] Refined nickel plus nickel content of ferronickel produced from concentrates unless otherwise specified.
[2] In addition to the countries listed, North Korea is believed to produce metallic nickel and/or ferronickel, but information is inadequate to make reliable estimates of output levels.
[3] Includes nickel content of nickel oxide and nickel fonte in addition to metallic nickel and ferronickel.
[4] Nickel content of ferronickel only (no refined nickel is produced).
[5] Nickel-cobalt content of ferronickel and matte produced.
[6] Individual figures for byproduct metal refinery and recovery from domestic ore are withheld as company confidential information.

capacity was completed during 1975 and the installation of additional equipment to handle 385,800 tons of concentrate per year was nearing completion. Modifications and new equipment added to the Kwinana refinery during the year, increased annual production to about 26,500 tons. Western Mining continued exploration around the Kambalda and St. Ives area and reported reserves of 27 million tons of ore grading 3.23% nickel. Production of concentrate from a joint venture at Windarra began in September 1974 and Western Mining received 3,614 tons of nickel plus copper as its share of the venture during 1974–75. Ore reserves at Mount Windarra and South Windarra reportedly were 8,100,000 tons grading 1.88% nickel. The company also purchased ore and concentrate from the Nepean mine jointly owned by Metals Exploration N.L. and Freeport and from the Scotia and Carr Boyd Rocks mines now wholly-owned by Great Boulder Mines Ltd. Production from the Carr Boyd Rocks mine was suspended at midyear 1975 because the mine was unprofitable. Production from the Scotia mine was hampered by a ground collapse in July 1974. Selcast Exploration Ltd. continued to supply nickel ore to Western Mining from its mine at Spargoville. Annual production of nickel from concentrate was reported to be 4,000 tons.

The Greenvale nickeliferous laterite project in Queensland was plagued with early startup troubles. The principal problem areas were in the crushing and grinding section, the feed system to the furnace, and in the oxide and sulfide product processing sections. The roasting furnaces and the leaching and carbonate extraction sections were performing satisfactorily. Floods, strikes, inflation, and currency changes have helped to increase the original 1971 estimated cost of the project from $250 million to $382 million. As a result of these increased costs, the project ran into financial troubles early in 1975. About midyear outside money lenders, already involved in the project, and the Queensland State Government agreed to assist Metals Exploration N.L. in obtaining the needed financial backing. Metals Exploration was to supply about $1.3

million of the total amount required with the remainder supplied by lenders in proportion to their other loans on the project. The Queensland Government was to guarantee the loans. Production during September averaged 80% of capacity (46 million pounds of nickel per year). Full capacity was expected to be reached at Greenvale and the Yabulu treatment plant by 1977.

A decision on whether to proceed with the Agnew nickel project in Western Australia was deferred by Western Selcast (Pty.), Ltd., and Mount Isa Mines, Ltd. (MIM). Reasons cited by company officials were inflation and increased operating costs in relation to the international price of nickel. Further, the financial viability of the project had not been established. Nevertheless, the situation was to be kept under constant review and design work was continued. The Agnew sulfide deposit was estimated to contain 45 million tons of ore averaging slightly more than 2% nickel with a cutoff grade of 1%.

A major new nickel venture was shaping up in Western Australia at yearend. The Forrestania project called for the development of the Digger Rocks nickel deposit (30%-owned by Endeavor Oil Co. NL) and the Cosmic Boy deposit (owned by AMAX Inc.). AMAX would act as manager of both deposits. Reserves of contained nickel were reported to be 137 million pounds at Digger Rocks and 240 million pounds at Cosmic Boy. The government had committed itself to permit the venture to proceed with only 30% equity participation by Australian companies. Western Mining was mentioned as a possible partner in the venture. Provided the program could get started early in 1976, production from the Digger Rocks deposit might be possible for mid-1979 and underground production from the Cosmic Boy deposit 19 months later. The Forrestania operation would be located 250 miles southeast of Perth and 150 miles southwest of Kalgoorlie.

Botswana.—Officials of Botswana Roan Selection Trust, Ltd. (BRST), stated that continuing technical problems associated with poor recoveries, lack of equipment, and the shutdown of the flash furnace earlier in the year for repairs resulted in a disappointingly low matte production of 7,103 tons, only 30% of designed capacity. Officials estimated that the rated capacity of about 23,700 tons of matte per year would be achieved in 1976. A pay dispute among African workers resulted in a strike at Pikwe on July 29, 1975. Production was resumed after police were called to disperse the crowds. Production loss from the strike amounted to about 4 days. Major damage to the smelter was averted by the police response. Had smelter technicians been delayed from attending the furnaces much longer, the smelter would have been put out of service for at least 6 months as a result of matte solidification.

Brazil.—Brazil currently has two nickel mines located in Minas Gerais producing about 220,000 tons of ore per year containing nearly 3,000 tons of nickel. The ore is smelted to ferronickel (containing 24% nickel).

Cia. Niquel Tocantins had reserves estimated at 22 million tons of ore grading 1.7% nickel at Niquelandia, Goiás. Empresa de Desenvolvimento de Recursos Minerais (Codemin), had ore reserves of 16.5 million tons grading 1.4% nickel also in Goiás.

The most advanced new nickel project in Brazil was that proposed by Baminco Mineração e Sidérurgia S.A. (BAMINCO) for development in the State of Goiás. Reserves were estimated at 44 million tons of ore with an average grade of over 1.9% nickel and a cutoff grade of 1.2%. Plans called for erection of a smelter near the deposit to produce about 50 million pounds of nickel per year as ferronickel. Implementation of the project is estimated at 38 months after a decision is made to proceed. An economic feasibility study was underway during 1975.

Canada.—In 1975 the value of nickel production exceeded copper as the most valuable Canadian metal produced (539.7 million pounds of nickel valued at C$1,110 million compared with 1,600 million pounds of copper valued at C$1,020 million). Canada continued to dominate as the leading producer of nickel in the world and accounted for 30% of the total world mine production. Nickel production was reported as 269,826 tons of contained metal, a 9% decrease from that produced in 1974. The principal producers of nickel in Canada remained INCO, Falco, and Sherritt Gordon Mines, Ltd.

INCO mined a total of 21.2 million tons of ore having an average nickel content of 1.40% in 1975 compared with 22 million tons having an average nickel content of 1.37% in 1974. Nickel production by INCO in 1975 was reported to be 460 million pounds compared with 510 million pounds in 1974. Principal reasons cited for reduced production were short strikes at the Sudbury and Shebandowan, Ontario, operations. INCO reported proven reserves in Canada of 415 million tons, containing 6.7 million tons of nickel and 4.3 million tons of copper. The company operated 16 mines during 1975, 13 in Ontario and 3 in Manitoba. INCO began work on developing a new mine in the Sudbury area known as Levack East. Production was to begin in 1984. Redevelopment work at the Victoria mine halted production at that mine in December 1975, production was scheduled to resume late in 1976.

The Kirkwood ore bodies were expected to become depleted during the first quarter of 1976 and would be closed. Work was continued on deepening the Birchtree mine and on underground exploration at the Pipe mine, both in Manitoba. INCO demonstrated a desire to diversify its activities by the acquisition of the Electric Storage Battery Co. (ESB); Daniel Doncaster & Sons Ltd. of Sheffield, United Kingdom (producers of forged and machined products for gas turbines); and its announced intentions to construct in the Sudbury district of Canada a $29 million direct rolling mill utilizing metal powders. The company also announced in April 1975 its participation in a multinational joint venture to mine manganese nodules from the ocean floor. Other members of the consortium were Deep Ocean Mining Co. Ltd. (DOMCO), representing Japanese companies; Metallgesellschaft AG, Preussag AG, Rheinische Braunkohlenwerke AG, and Salzgitter AG from West Germany; and a U.S. company, SEDCO, Inc., of Dallas. The members were conducting feasibility studies during 1975.

Falco and Sherritt Gordon remained the number 2 and 3 producers, respectively, of nickel in Canada in 1975. Falco's Sudbury operations were shut down for 73 days in 1975 as production and maintenance workers went on strike. The company was forced to cutback production at its mines and plants by 30% after the strike because of reduced world demand for nickel. Output at the Falco refinery in Norway was curtailed in August as a result of the strike and remained at about two-thirds of normal capacity through yearend. Also, the East, Onaping, and Longvack South mines; the Fecunis mill; and one of two blast furnaces at the smelter were shut down and placed on standby status. Major capital projects at Sudbury (excluding development of the Lockerby mine) were suspended. Principal among these projects was the $95 million environmental improvement program for the smelter. Much construction work has been completed on the project. As a result of these actions, Falco reported that deliveries of refined nickel in 1975 totaled 61.5 million pounds compared with 89.5 million pounds in 1974. At yearend the Ontario Government deferred for 5 years its ruling that would have disallowed the deduction from taxes of the cost of processing minerals outside of Canada. Had the ruling been imposed, it would have cost Falco $8 million for 9 months of 1974 (levy's effective date was originally April 9, 1974).

Falco conducted research and development work in 1975 on mineral dressing techniques in order to increase metal recoveries at its Sudbury operations and to assist Sturgeon Lake Mines Ltd. in improving metal recoveries. A new method for hydraulically hoisting lump ore at the Onaping mine was deferred as a result of the mine being shut down. Ore reserves at yearend 1975 were reported as 89.1 million tons containing 1,279,000 tons of nickel. This was 1,479,000 tons of ore below the yearend 1974 quantity, the result of mining 3,230,000 tons of ore during the year.

Sherritt Gordon experienced a shortage of feed material during the second quarter of 1975 that restricted nickel production at its Fort Saskatchewan plant. Reportedly, the company shut down the refinery for 6 weeks (from mid-June to the end of July) for maintenance. The company expected to achieve closer-to-optimum operating levels during the final 5 months of 1975. The Lynn Lake mill improved its previous operations during the second quarter of 1975.

Production, as measured by sales and deliveries and reported by the three principal Canadian producers in 1975, was as follows:

Company	Type of operation	Thousand pounds
The International Nickel Co. of Canada, Ltd	Delivery	351,120
Falconbridge Nickel Mines, Ltd	do	61,524
Sherritt Gordon Mines, Ltd	Sales	20,036

Union Minière Explorations and Mining Corp. Ltd. was developing a new copper-nickel mine at Pickle Lake in Northwestern Ontario. Reportedly the mine will be a combination of open pit and underground operations and has sufficient ore reserves to last 20 years. To date, preliminary mine design, as well as geotechnical and environmental studies, have been completed.

Colombia.—Early in 1975 Hanna Mining Co. querried several Japanese stainless steel producers on the possibility of taking part in a joint venture to develop its nickel deposits at Cerro Matoso. A feasibility study was to be completed in 1975 on the project. Reportedly, a pilot plant was being constructed and preliminary financing inquiries were made both in the United States and Europe. Preliminary plans called for construction of a ferronickel plant with an annual capacity of 23,000 tons of nickel.

Cuba.—Reportedly, Soviet technicians were working on the nickel facility at Nicaro during 1975. The project was undertaken to construct new shops, modernize a railroad, and renovate the plant which was built during World War II. Expansions at Nicaro and Moa Bay will increase Cuba's nickel capacity by nearly 11,000 tons per year.

Dominican Republic.—Falconbridge Dominicana, C. por A., mined 2.3 million dry tons of lateritic ore in 1975. Deliveries of ferronickel in 1975 were reported as 52,329,000 pounds (contained nickel) compared with 68,709,000 pounds in 1974. Ore reserves were stated as 64 million dry tons grading 1.58% nickel at yearend. The company continued exploration within the concession area; the results were being evaluated at yearend.

France.—The French Government set aside about $56.5 million for developing a raw materials stockpile. The major portion of the money was destined for purchases of copper and nickel in 1975. The purpose of the stockpile was to protect industrial consumers against sudden fluctuations in metal prices. Metal stocks were stored throughout the country with consideration going to locations near specific metal consumers. The nickel stockpile was being managed by the nickel producer at Le Havre and was set up to assist SLN of New Caledonia through periods of poor marketing conditions. The nickel stockpile was to be about 10,000 tons of nickel metal and cover an acquisition period of 5 years.

Guatemala.—Exploraciones y Explotaciones Mineras Izabal, SA (Exmibal), reported that construction of facilities for its lateritic nickel project near Lake Izabal in eastern Guatemala neared the halfway mark at yearend. During 1975 construction and operating personnel amounting to 2,000 were employed at the site. The project was expected to begin operations in 1977 with a capacity of 28 million pounds of nickel per year in nickel matte. The cost of the project was revised in 1975 to $224 million.

Greece.—Expansion of the Société Minière et Métallurgique de Larymna S.A. (LARCO) ferronickel plant from 18,000 tons of nickel per year to 36,000 tons was awaiting government approval at yearend. LARCO processes 700,000 tons of ore per year into ferronickel containing 27% nickel. Ore reserves in the Larymna area were reported to be 100 million tons. A second proposal also was being considered by the government to combine steel production with the nickel output. Costs of the two projects were estimated to be $75 million and $220 million, respectively.

Indonesia.—INCO, the major share holder in P.T. International Nickel Indonesia, stated that construction of facilities for the first stage of its lateritic nickel operation was 60% complete at the end of 1975. During the year, nearly 6,500 construction and operating personnel were employed. The first stage, designed to produce 35 million pounds of nickel per year in matte, was expected to be operational by the latter half of 1976. In November 1975 the estimated cost of the project was escalated upward to $820 million. An agreement was reached during the year between INCO and the Indonesian Government for the construction and operation of a 110-megawatt hydroelectric plant on the Larona River. A major portion of the electricity will supply power to the nickel operation when it is expanded to 100 million pounds per year of nickel in 1978. Site preparation for the dam was started during the year.

P. N. Aneka Tambang (ANEKA) held discussions with four Japanese ferronickel producers during 1975 about the possible future supply of ferronickel to Japan. A ferronickel plant was to be completed in November 1975 and ferronickel was to begin being produced in April 1976 at a rate of 385 tons per month. The Japanese companies have contracted to purchase the output for 10 years. ANEKA was Indonesia's only producer of nickel ore in 1975. Near midyear 1975, ANEKA agreed to reduce ore shipments to Japan by about 30% for the fiscal year (April 1975 to March 1976). The shipments were to be reduced from 750,000 to 600,000 tons. The exported ores graded 2.4% nickel plus cobalt and 27% moisture.

Plans for the P.T. Pacific Nikkel Indonesia project were stalled near midyear as a result of cost escalation. Recent findings by Bechtel Corp. in a feasibility study increased the cost of the 100 million-pound-per-year operation to $700 million. The Gag Island project has been under study and development since 1968.

The Indonesian Nickel Development Co. (INDECO), a partnership of Japanese steel and trading firms, continued to explore for nickeliferous laterites. Attention was centered on the ores of Gebe Island near Halmahera. A feasibility report on the project was to be completed in September 1975.

Japan.—Japanese ferronickel producers, faced with large surpluses of nickel due to slack demand, requested Indonesian and New Caledonian ore exporters to reduce their shipments for the year. In order to reduce stocks of nickel, Japan's Ministry of International Trade and Industry (MITI) resumed the issuing of export licenses for nickel and nickel alloys. The new ceiling of up to 2,000 tons (total exports) was to remain in effect until March 1976. MITI officials stated that this ceiling would be increased if conditions required it.

Pacific Metals Co. of Japan attempted to interest five other Japanese firms in becoming joint owners in a new 44,000-ton-per-year ferronickel smelter in Niigata Prefecture. The first phase of the project (18,000 tons) was scheduled to begin early in 1976. Annual capacity was to be increased to 27,500 tons and finally to 44,000 tons in later years. First phase costs were estimated at $66.7 million. In a separate action, Shimura Kako Co. Ltd. (30% owned by INCO) was considering a plan to give INCO a larger share in the nickel refining company. Reportedly the company had been operating at a loss.

New Caledonia.—Production of nickel ore in New Caledonia in 1975 was 4% less than that produced in 1974 and totaled 7.4 million tons. Nickel smelter production increased 5% in 1975 over that of 1974 and totaled 78,338 tons. Ferronickel production increased nearly 9% and totaled 58,204 tons, but matte production decreased 3% from that of 1974. Exports of nickel ore to Japan decreased 26% in 1975 when compared with exports in 1974 and reflected Japanese requests for reductions in New Caledonian exports. Exported ore averaged 2.46% nickel plus cobalt.

Much discussion occurred during 1975 regarding the development of nickel deposits in the northern part of New Caledonia (Poum and Tiebaghi deposits). Compagnie Française d'Entreprises Minières, Métallurgiques et d'Investissements (COFREMMI) had its mining rights to New Caledonian nickel deposits suspended early in 1975. AMAX appeared interested in becoming a partner in developing these deposits, but the French Government apparently was holding up a decision on development until additional French interests in the project could be found. By midyear, the Minister of Overseas Departments and Territories announced that the government would participate in the project up to a possible 51% if no other French interest could be found. At yearend, AMAX reportedly was waiting for the French Government to make the next move in putting together a team to develop the project.

SLN officials announced plans to begin a $230 million expansion of its New Caledonian production facilities. The expansion would increase capacity of the Doniambo smelter from 70,000 to 90,000 tons per year by 1979.

Early in 1975 INCO won a tentative 2-

year delay from the French Government in which to make its decision about developing the Goro deposit in southern New Caledonia. The French Government divided the Goro deposit in half with INCO getting the western portion (with a 2-year delay) and Société Nationale des Pétroles d'Aquitaine (SNPA) getting the eastern portion. As a result of the division INCO was expected to offer a scaled-down development plan.

The long-awaited New Caledonian tax reform was approved in 1975. The new tax law will substitute a 50% tax on profits from the off-island sale of ferronickel and matte for the current 11% value added tax on all nickel exports. Reportedly, France will provide, for a period of more than 5 years, any revenue shortfall in that portion of the New Caledonian budget normally obtained from nickel taxes. Revenues from nickel have accounted for about 25% of the island's budget in recent years. Nickel processors would be required to pay a minimum guaranteed revenue equal to a 3% ad valorem tax on exported products. This export tax would be paid in full if processors recorded zero profits or deficits, and as a differential for any shortfall in profit taxes below the minimum guaranteed revenue.

Philippines.—Marinduque Mining & Industrial Corp. operated its new nickel facilities on Nonoc Island at about 27% of rated annual capacity (75 million pounds per year of nickel briquets and powder) during 1975. Operating capacity increased near yearend, 39% in November and 45% in December. Reportedly, the company produced 6.2 million pounds of pure nickel in the first half of 1975. Delays were encountered during the year as sections of the plant were redesigned. The company was considering building a hydroelectric powerplant that was expected to cut fuel oil requirements in half. The hydroelectric project would require up to 3 years to complete, once financing was found. At yearend, Marinduque was attempting to reschedule a portion of the nickel project's indebtedness. Officials hoped to reschedule $20.4 million due in 1976 so as to be payable over a 3-year period in quarterly installments beginning in January 1978. An additional $32 million due in January 1979, hopefully would be rescheduled over a 3-year period in quarterly payments beginning in January 1979.

The Japanese Government announced that an $18 million loan had been granted for the development of nickel ore reserves in the Philippines. The development company would be Rio Tuba Nickel Mining Corp. in which Pacific Metals Co. of Japan owned 40%. The company would produce 386,000 tons of ore the first year and 550,000 tons each succeeding year for shipment to Japanese ferronickel smelters. Total reserves were estimated at 22 million tons grading 2.2% nickel.

Rhodesia, Southern.—Rhodesia's fourth major nickel producer began operations at the Shangani mine in October 1975. Two separate ore bodies exist at the Shangani deposit. The larger eastern ore body had been estimated at 17.6 million tons grading 0.92% nickel and 0.12% copper. Initially the deposit will be mined at an annual rate of 992,000 tons of ore delivered to the concentrator for a period of 7 years, after which ore will be supplied from an underground mine. The concentrate will be shipped by rail some 200 miles to Rhodesian Nickel Corp. Ltd.'s (Rhonickel) Bindura smelter. The smelter recently underwent expansion in order to handle the Shangani concentrates as well as Rhonickel's output from the small Epoch mine. The smelter was originally designed to process concentrates from Rhonickel's Bindura and Madziwa mines. The Epoch mine is being developed at a cost of $11.9 million and was expected to be operational early in 1976. Reserves at Epoch were reported to be 2.75 million tons of ore grading 0.75% nickel. Mining was expected to last for about 8 years. Reportedly, Rio Tinto (Rhodesia) Ltd.'s Perseverence nickel mine was shut down in 1975 pending a metallurgical solution to the ore's high-arsenic content. The smelter feed ratio of Perseverence to Empress ore was adjusted to compensate for the high arsenic content of the Perseverence ore. Stockpiled ore at the Perseverence mine was sufficient to maintain smelter production for about a year, after which Rio Tinto will resume mining the Perseverence ore.

Yugoslavia.—Feni Kombinat of Yugoslavia reportedly began work on its new mine site at Rzanovo, 24 miles southwest of Kavadarci in November 1974. The Feni reserves are in three main ore bodies: The Rzanovo, estimated to contain 38 million tons of nickeliferous ore; the Bojančište, just north of Rzanovo, estimated at 400,000 tons which will be mined by open pit techniques; and the Studena Voda (an extension of the Rzanovo deposit), estimated to contain 200,000 tons but had not been fully explored. The ore was reported to assay 17.1% to 46% iron; 0.6% to 1.4% nickel; 0.02% to 0.14% cobalt; 0.9% to 2.2% chromium; 19% to 37% silicon dioxide; and 7% to 17% magnesium dioxide. The ore was to be smelted to a crude FN4 ferronickel containing about 19% nickel. Additional refining will remove iron and minor impurities and upgrade the product to FN1 ferronickel containing 25% nickel. If it is required, a 45% nickel content product would be produced. Pigs weighing about 66 pounds will be cast. Arthur G. McKee & Co. of Cleveland, Ohio, signed an engineering contract on May 16 with Feni. McKee will provide basic engineering and help coordinate construction of the complex.

TECHNOLOGY

Bureau of Mines scientists reported research results on recovering nickel and cobalt from low-grade domestic laterites.[4] The Bureau's process involves selective reduction of laterite ore with carbon monoxide at temperatures ranging from 350° to 600° C. Materials containing more than 5% magnesia required additions of pyrite or postreduction heat treatments to achieve satisfactory nickel and cobalt extractions for this range of reduction temperatures. The reduced material was leached in multistages at ambient temperature and pressure in the presence of oxygen, ammonium sulfate, and ammonium hydroxide. Extractions were about 90% and 85% of the contained nickel and cobalt, respectively. Bureau of Mines researchers also reported on the copper-nickel mineralization of the Duluth Gabbro complex. A microscopic study was performed to determine the mineralogy and paragenesis of the ore minerals. Major sulfide minerals were chalcopyrite, cubanite , pyrrhotite, troilite, and pentlandite.[5] Other published reports by the Bureau of Mines described the thermodynamic properties of Al–Ni alloys containing 0.54 to 30.04 atomic-percent nickel.[6] The chlorination kinetics of selected metal sulfides, including nickel sulfide, were described in a separate report.[7]

Scientists from four Bureau of Mines metallurgy research centers continued to carry out nickel related research. Research programs included the extraction of nickel and cobalt from domestic oxide ores and nickel-copper sulfide ores in an attempt to optimize operating parameters. Other areas being studied were the recovery of cobalt and nickel as byproducts of concentrating and smelting Missouri lead ores, development of a process for economically recovering manganese and other metals from calcareous Atlantic Ocean nodules from the Blake Plateau and from the Pacific Ocean, and the development of an environmentally acceptable method for treating copper and nickel sulfide ores associated with the Duluth Gabbro complex.

A solvent extraction process for the separation of cobalt from nickel was described in a paper by researchers from the Canadian Government's Mines and Resources Department in Ottawa.[8] After the cobalt and nickel are leached from ores, residues, alloys, or other materials with conventional inorganic acids, unwanted metals are removed. The remaining solution containing cobalt and nickel is treated with either sodium or ammonium salt of di(2-ethylhexyl) phosphoric acid which extracts most of the cobalt and a small amount of nickel. Cobalt is recovered from the solvent by acid stripping. In a somewhat related report, the researchers investigated the extraction and separation of copper, nickel, zinc, and cobalt from ammoniacal solutions using Kelex 100.[9]

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[4] Siemens, R. E., P. C. Good, and W. A. Stickney. Recovery of Nickel and Cobalt From Low-Grade Domestic Laterites. BuMines RI 8027, 1975, 14 pp.

[5] Boucher, M. L. Copper-Nickel Mineralization in a Drill Core From the Duluth Complex of Northern Minnesota. BuMines RI 8084, 1975, 55 pp.

[6] Schaefer, S. C. Thermodynamic Properties of the Al–Ni System. BuMines RI 7993, 1975, 15 pp.

[7] Landsberg, A., A. Adams, and J. L. Schaller. Chlorination Kinetics of Selected Metals Sulfides. BuMines RI 8002, 1975. 15 pp.

[8] Ritcey, G. M., A. W. Ashbrook, and B. H. Lucas. Development of a Solvent Extraction Process for the Separation of Cobalt From Nickel. Can. Min. and Met. Bull., v. 68, No. 753, January 1975, pp. 111–123.

[9] Ritcey, G. M., and B. H. Lucas. Extraction and Separation of Copper, Nickel, Zinc and Cobalt From Ammoniacal Solution Using Kelex 100. Can. Min. and Met. Bull., v. 68, No. 754, February 1975, pp. 105–113.

A newly developed sealed nickel-hydrogen battery was announced which offers advantages over such batteries as nickel-cadmium, lead-acid, silver-zinc, and the regenerative H_2–O_2 fuel cell.[10] Advantages claimed for the new cell are that it is lightweight and has a longer life, higher energy, and increased power densities. Reportedly, over 5,000 high rate discharge-charge cycles were completed on small 1.5 ampere-hour cells with good voltage performance. NASA's Jet Propulsion Laboratory tested similar cells in high altitude, zero-G flights from the White Sands, N. M., testing grounds. Reportedly, the cells performed well under heavy discharge conditions. Studies indicated the possibility of 50% more charge-discharge cycles than are possible with nickel-cadmium cells. In a somewhat related development, nickel-zinc batteries were described that may eventually supplement, rather than replace conventional lead-acid batteries.[11] The Lewis Research Center in Cleveland, Ohio, was preparing to test these batteries in an electric vehicle (EV) used to deliver mail on the Center's property. Spokesman for the Center believed that the use of nickel-zinc batteries would give EVs a range of 80 to 100 miles compared with a range of 40 to 50 miles for lead-acid batteries before recharging is required. A new wrought aluminum-nickel alloy for high strength-high conductivity applications was developed.[12] These alloys contain from 0.06% to 6.1% (by weight) nickel and can be processed into wire as easily as aluminum. The wire possesses the desired characteristics of high strength-high electrical conductivity.

A new nickel-iron alloy (Niron) was developed by the Udylite Co., Division of Oxy Metal Industries Corp., Warren, Mich., as a substitute for nickel in electroplating.[13] The alloy gives the brilliance, leveling, durability, and speed of bright nickel plating with the economy of iron. The deposit was reported to be ductile, to have good corrosion resistance, and to accept a chromium deposit well. Use of the Niron process allows a deposit of an alloy containing 15% to 30% iron in place of one made entirely of nickel. Reportedly, economies result not only from reduced nickel consumption but also from the elimination of nickel chloride and the extension of the life of anode bags and filters. Officials of Corning Glass Works announced the development of a plating chemical recovery system for chrome and nickel that could possibly reduce consumption by 50% to 90%.[14] The unit was referred to as a climbing film evaporator.

Deep Ocean Minerals Association (DOMA) announced plans to build a new research vessel to be used to survey for deep sea manganese nodules.[15] The ship will be equipped with a radioactive (gamma ray) surveying system to measure nodule quality, an automatic route map preparation system to outline nodule distribution and quality, an ultrasonic system to permit high-precision surveying of ocean bottoms, and a system for collecting nodules from the deep ocean. Also under development, was a high-speed television system to permit picture taking of nodules while the ship is moving at high speeds.

A company official for Frankel Company, Inc., described how to make use of technology to identify and segregate expensive scrap for recycling.[16] The company processes lathe turnings, stamping trim, and other manufacturing scrap metals which a short time ago were considered worthless. The volume of scrap recycled at Frankel has reached 2 million pounds per year. Alloy scrap identified and processed included INCO alloys 718 and 901, Waspalloy, and Hastelloys. The firm relies on atomic absorption spectrophotometers, a direct reading X-ray fluorescence spectrometer, and an automatic carbon and sulfur determinator. The chips are sorted and identified, chopped, crushed or sheared, washed to remove soil, dried, screened, and boxed according to customer specifications.

Nonmetallic composite jet fan blades

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[10] Giner, J., and J. D. Dunlop. The Sealed Nickel-Hydrogen Secondary Cell. J. of the Electrochem. Soc., v. 122, No. 1, January 1975, pp. 4–11.

[11] American Metal Market. 'Exotic' Batteries to Supplement Lead Units, Say Gould Officials. V. 82, No. 187, Sept. 26, 1975, p. 8.

[12] Rohatgi, P. K., and K. V. Prabhakar. Wrought Aluminum-Nickel Alloys for High Strength-High Conductivity Applications. Met. Trans. A, v. 6A, No. 5, May 1975, pp. 1003–1008.

[13] Obrzut, J. J. Nickel-Iron Alloy Saves on Electroplating Costs. Iron Age, v. 216, No. 17, Oct. 27, 1975, pp. 58–59.

[14] American Metal Market. Corning Develops Chrome, Nickel Recovery System. V. 82, No. 33, Feb. 17, 1975, p. 24.

[15] American Metal Market. DOMA Plans Construction of Second Research Ship for Surveying of Nodules. V. 82, No. 18, Jan. 27, 1975, pp. 3A, 8A.

[16] DuMond, T. C. Alloy Recovery Possible Through Chip Processing. Iron Age, v. 215, No. 17, Apr. 28, 1975, pp. 43–44.

were tested during 1975 as a possible substitute material for traditional titanium fan blades.[17] The leading edge has a damage resistant electro-deposited nickel-cobalt sheath. The U.S. Air Force was evaluating the new composite blades in actual flight tests in a F-111D fighter. The all composite third-stage blades were reported to be 40% lighter than conventional titanium blades. The composite blades were made from 4.2 mil silicon-carbide-coated boron filaments. Maximum use of the material in a jet engine could reduce the engines weight by 15% to 20% according to the Air Force project manager.

A new method has been developed for die casting of ferrous metals and nickel and cobalt alloys.[18] Principal difficulty in diecasting of these materials has been that die materials cannot withstand the casting metal's temperature. The GKN Group Technological Center at Wolverhampton, England, developed a Ferro-Di process which utilizes a titanium-zirconium-molybdenum insert in the die. The Massachusetts Institute of Technology, Department of Materials Science and Engineering, was researching a diecasting method in which conventional die materials were used but the molten metal was agitated into a slurry. This method effectively reduced the alloy temperature. The Ferro-Di process has been developed into a production reality for diecasting of numerous metals and alloys.

A new superalloy Pyromet CTX-1 was developed which has mechanical properties about equal to Alloy 718, but a mean coefficient of thermal expansion only about one-half of alloy 718.[19] The new alloy has no chromium in its composition but still retained its corrosion and oxidation resistance.

A high level of industrial activity was evident from the large number of patents issued during 1975. The patents covered a wide range from mining through extractive metallurgy (both pyrometallurgy and hydrometallurgy) to processing technology. The processes were directed toward the recovery of nickel from lateritic and sulfide ores and deep ocean manganese nodules. The significance of a developing technology for mining and processing deep ocean nodules was evident from the large number of patents issued on the subject during 1975.

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[17] Industrial Research. Composite Blades Take to the Air. V. 17, No. 12, November 1975, p. 55.

[18] Iron Age. New Research Promotes Ferrous Die Casting. V. 215, No. 24, June 16, 1975, pp. 46-47.

[19] Muzyka, D. R., C. R. Whitney, and D. K. Schlosser. Physical Metallurgy and Properties of New Controlled-Expansion Superalloy. J. of Met., v. 27, No. 7, July 1975, pp. 11-15.

Nitrogen

By Russell J. Foster [1]

Fixed nitrogen production of 13.6 million short tons and elemental nitrogen production of 9.2 million short tons were 4% and 7%, respectively, above 1974 output. Exports of contained nitrogen increased 20%, and imports rose 12%. As in 1974, the United States was a net importer of fixed nitrogen. Domestic consumption, including net imports of 102,000 tons, was essentially unchanged at 13.0 million tons of fixed nitrogen. Domestic consumption of elemental nitrogen was considered equal to production.

Table 1.—Salient nitrogen statistics
(Thousand short tons of contained nitrogen)

	1971	1972	1973	1974	1975 p
United States:					
Production as ammonia	12,107	12,651	r 12,641	13,121	13,595
Production as elemental nitrogen [1]	6,087	7,011	8,263	8,585	9,180
Exports of nitrogen compounds [2]	999	1,310	1,506	999	1,194
Imports for consumption of nitrogen compounds [2]	907	947	r 967	1,154	1,296
Consumption [3]	11,903	12,333	r 12,708	13,046	13,019
World: Production [2]	45,357	47,398	r 51,500	53,400	52,300

p Preliminary. r Revised.
[1] Converted from reported volume (at 70°F and 1 atmosphere pressure) at 27,605 cubic feet per short ton.
[2] Estimated, excludes elemental nitrogen.
[3] Includes producers' stock change in synthetic anhydrous ammonia and coke oven ammonium compounds; excludes elemental nitrogen.

Legislation and Government Programs.—The Environmental Protection Agency began an investigation of nitrosamines as cancer-causing agents. These compounds are formed by the combination of amines and nitrates, some of which are found in water due to fertilizer and pesticide runoff.[2]

The Occupational Safety and Health Administration, proposed tougher controls on worker exposure to ammonia, including a ban on all worker contact with liquid ammonia. High exposure to ammonia can lead to acute lung congestion, followed by bronchitis or pneumonia with possible permanent lung damage and even death from concentrations of several thousand parts per million.[3]

Ammonium sulfate and mixed and blended fertilizers were included in the fertilizer manufacturing category when final effluent limitations guidelines for existing sources and standards of performance and pretreatment standards for new sources were established.[4] Twelve companies representing the major nitrogen fertilizer manufacturers joined in a petition for judicial review of the regulations for nitrogen fertilizers, including urea. Data and information received from industry contributed to

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] New York Times. Cancer Peril in Air and Water Studied. Sept. 20, 1975.
[3] Wall Street Journal. Exposure to Sulfur Dioxide, Ammonia Would Be Cut Under Labor Agency Plan. Nov. 17, 1975, p. 14.
[4] Federal Register. Environmental Protection Agency. Fertilizer Manufacturing Point Source Category. V. 40, No. 9, Jan. 14, 1975, pp. 2650–2655.

the development of new urea regulations, which apply to plants that started prilled urea production after January 1, 1970, and to new sources. A further study will be undertaken for use in developing regulations for plants that began production before January 1, 1970, and for plants that do not prill urea product.[5]

DOMESTIC PRODUCTION

Domestic production of fixed nitrogen, as anhydrous ammonia, increased 4% over that of 1974 to nearly 13.6 million short tons. Elemental nitrogen production rose 7% to 9.2 million short tons.

Ammonia producers have succeeded in trimming their needs for natural gas in all production activities, according to an energy survey conducted by The Fertilizer Institute. The use of gas was down from 40,706 cubic feet per ton of ammonia produced in 1972 to 39,397 cubic feet per ton of ammonia in 1975, a drop of 3%. However, total Btu consumption rose slightly because less efficient sources of energy, such as fuel oil, were employed for some nonfeedstock use.[6]

The Council on Environmental Quality was urged to give heavy emphasis to the energy needs of the fertilizer industry in reporting to the President and Congress. The Fertilizer Institute pointed out that ammonia plants were forced to cut production by 356,000 tons in 1975 because of gas curtailments.[7]

Canada announced an increase in the price of natural gas exported to the United States. On August 1, the price was raised by 40% to $1.40 per 1,000 cubic feet and this was followed by a further increase in November to $1.60 per 1,000 cubic feet. The change in price affected U.S. ammonia producers in the Midwest and on the Pacific Coast.[8]

Farmland Industries Inc. announced its intention to build a 420,000-ton-per-year ammonia plant, due onstream in 1978, at Alexandria, La.[9] A 385,000-ton-per-year unit, due onstream by 1977–78, was already under construction by M. W. Kellogg Co., at Enid, Okla. Farmland's 200,000-ton-per-year urea-ammonium nitrate solutions facility at Dodge City, Kans., came onstream in January 1976. In addition, a 350,000-ton-per-year ammonium nitrate plant was planned for Enid, Okla.[10]

As Agrico Chemical Co. brought its Verdigris, Okla., fertilizer complex onstream, the company announced that ammonia capacity would be doubled to 850,000 tons per year. The $35 to $40 million expansion project was due for startup in 1977.[11] Agrico's 300,000-ton-per-year urea plant, constructed at Blytheville, Ark., came onstream in the spring of 1976.[12]

CF Industries, Inc., awarded Foster Wheeler Corp. and Hoechst-Uhde Corp. two contracts totaling $23.5 million to design and engineer fertilizer production facilities to include a 1,500-ton-per-day urea plant, a 520-ton-per-day nitric acid plant, a 660-ton-per-day ammonium nitrate plant, and a 500,000-ton-per-year 32% urea-ammonium nitrate solutions plant at Donaldsonville, La. Completion was slated for mid-1977.[13]

Air Products and Chemicals, Inc., announced plans to increase its New Orleans, La., ammonia production capacity by 250 tons per day. The new capacity was expected onstream in January 1976. Since a grassroots ammonia facility could take about 3 years to complete, Air Products bought certain idle ammonia production equipment to facilitate rapid construction.[14] The company also planned to construct a 300-ton-per-day nitrogen-oxygen-argon facility at La Salle, Ill.[15]

Monsanto Co. chose M. W. Kellogg to

[5] Federal Register. Environmental Protection Agency. Fertilizer Manufacturing Point Source Category. V. 40, No. 162, Aug. 20, 1975, pp. 36337–36339.

[6] Fertilizer Progress. Energy Use in Fertilizer. V. 6, No. 6, November/December 1975, p. 32.

[7] Chemical Marketing Reporter. Fertilizer Industry Seeks Energy Help From ERDA Effort. V. 208, No. 10, Sept. 8, 1975, pp. 5, 13.

[8] Fertilizer International. U.S. Ammonia Producers Face Higher Feedstock Charges. No. 73, July 1975, p. 3.

[9] Fertilizer International. Plant & Project News. No. 76, October 1975, p. 10.

[10] Nitrogen. New Plants and Projects. No. 98, November/December 1975, p. 18; No. 101, May/June 1976, p. 13.

[11] Chemical Engineering. Expansion Planned for New Ammonia Plant. V. 82, No. 11, May 26, 1975, p. 63.

[12] Nitrogen. New Plants and Projects. No. 94, March/April 1975, p. 20; No. 101, May/June 1976, p. 13.

[13] Chemical Engineering. CPI News Briefs. V. 82, No. 11, May 26, 1975, p. 137.

[14] Chemical Engineering. CPI News Briefs. V. 82, No. 7, Mar. 31, 1975, p. 133.

[15] Nitrogen. New Plants and Projects. No. 93, January/February 1975, p. 15.

design a 400,000-ton-per-year ammonia plant to expand its facilities at Luling, La. The plant, which would more than double the existing ammonia capacity at the site, was given a startup date of late 1976.[16] Allied Chemical International reopened a 100,000-ton-per-year ammonia plant at Southpoint, Ohio.[17]

Construction began in April on the $8.4 million expansion of Kaiser Aluminum & Chemical Corp.'s Savannah, Ga., nitrogen complex. Modifications will increase production capacity for ammonium nitrate solutions and urea.[18]

Beker Industries Corp. planned to build a 127,000-ton-per-year ammonia unit at Carlsbad, N. Mex. The ownership of the plant will be a joint venture with Texasgulf, Inc. Another larger plant, formerly operated by Northern Illinois Gas Co. was relocated and reactivated by Beker at the site, and a 160,000-ton-per-year urea plant came onstream there in late 1975.[19]

Mississippi Chemical Corp. announced plans to reactivate a portion of its original Yazoo City, Miss., ammonia plant and tie it into the existing 1,000-ton-per-day ammonia unit. Nearly 53,000 tons per year of additional ammonia production was expected when the $2.9 million project was completed in fall 1975. This construction was in addition to a $60 million, 2-year expansion already underway at the Yazoo City and Pascagoula, Miss., facilities.[20]

International Minerals & Chemical Corp. and Commercial Solvents Corp. scheduled a 1,150-ton-per-day ammonia fertilizer facility at Sterlington, La., with a projected opening in early 1977. Columbia Nitrogen Corp. announced plans to start production at a 1,500-ton-per-day ammonia plant in the Southeastern United States in early 1978. Collier Carbon & Chemical Corp. had in the engineering stage a 1,500-ton-per-day ammonia plant and a 1,200-ton-per-day granulated urea unit to be located at Kenai, Alaska.[21]

The Federal Power Commission denied USS Agri-Chemicals, Inc.'s priority for natural gas supplies to its 177,000-ton-per-year ammonia plant at Cherokee, Ala.[22] Shortages of natural gas at Vistron Corp.'s 510,000-ton-per-year ammonia plant at Lima, Ohio, forced the company to appeal to the Federal Power Commission. Early in 1975 gas supplies to the plant from Columbia Gas of Ohio were cut by 30% to 55%, and the company was notified that a 60% reduction was planned during the 5-month heating season starting November 1. The shortages have curtailed Vistron's ability to serve an estimated 66,000 farmers in seven Midwestern States.[23]

[16] Fertilizer International. Plant & Project News. No. 69, March 1975, p. 12.
[17] Work cited in footnote 15.
[18] Nitrogen. New Plants and Projects. No. 96, July/August 1975, p. 18.
[19] Nitrogen. New Plants and Projects. No. 95, May/June 1975, p. 15.
[20] Chemical Marketing Reporter. Ammonia Reactivated by Mississippi Chemical. V. 207, No. 1, Jan. 6, 1975, pp. 3, 16.
[21] Chemical Engineering. C. E. Construction Alert. V. 82, No. 7, Mar. 31, 1975, pp. 110–111.
[22] Fertilizer International. Threat of Further Gas Curtailments for U.S. Ammonia Producers. No. 68, February 1975, p. 4.
[23] Chemical Week. Fertilizer Maker Asks Help in Getting More Gas. V. 117, No. 2, July 9, 1975, p. 13.

Table 2.—Nitrogen production in the United States
(Thousand short tons of contained nitrogen)

	1971	1972	1973	1974	1975 p
Anhydrous ammonia: Synthetic plants 1	11,972	12,512	r 12,508	12,999	13,482
Ammonium compounds, coking plants:					
Ammonia liquor	12	11	6	6	5
Ammonium sulfate	114	128	127	116	108
Ammonium phosphates	9	(2)	(2)	(2)	(2)
Total	12,107	12,651	r 12,641	13,121	13,595
Elemental nitrogen 1	6,087	7,011	8,263	8,585	9,180

p Preliminary. r Revised.
1 Bureau of the Census Current Industrial Reports.
2 Included with ammonium sulfate to avoid disclosing individual company confidential data.

Table 3.—Major nitrogen compounds produced in the United States
(Thousand short tons, gross weight)

Compound	1974	1975 p
Acrylonitrile	706	607
Ammonium nitrate	7,542	6,963
Ammonium sulfate [1]	2,061	2,029
Ammonium phosphates	6,816	7,564
Nitric acid	8,120	7,078
Urea	3,789	3,695

p Preliminary.
[1] Includes ammonium sulfate from coking plants.

Sources: Bureau of the Census and International Trade Commission.

Table 4.—Domestic producers of ammonium nitrate
(Thousand short tons per year of NH_4NO_3)

Company	Location	Capacity
Agrico Chemical Co.—Williams	Henderson, Ky	100
Agway, Inc	Olean, N.Y	69
Air Products & Chemicals, Inc	Pace Junction, Fla	200
Allied Chemical Corp	La Platte, Nebr	112
Do	Geismar, La	290
American Cyanamid Co	Hannibal, Mo	132
Apache Powder Co	Benson, Ariz	66
Atlas Chemical, Inc	Joplin, Mo	233
Do	Tamaqua, Pa	40
Carolina Nitrogen Corp	Wilmington, N.C	188
CF Industries, Inc	Fremont, Nebr	32
Do	Terre Haute, Ind	160
Chevron Chemical Co	Richmond, Calif	41
Do	Fort Madison, Iowa	78
Do	Kennewick, Wash	150
Collier Carbon & Chemical Corp	Brea, Calif	60
Columbia Nitrogen Corp	Augusta, Ga	208
Cominco American Inc	Beatrice, Nebr	175
E.I. du Pont de Nemours & Co	Gibbstown, N.J	50
Do	Louviers, Colo	12
Do	Seneca, Ill	158
Do	Du Pont, Wash	16
Farmers Chemical Association—CF Industries, Inc.	Tunis, N.C	165
Do	Tyner, Tenn	165
Farmland Industries, Inc	Lawrence, Kans	270
Gardinier, Inc	Helena, Ark	96
Goodpasture, Inc	Dimmitt, Tex	37
Gulf Oil Corp	Pittsburg, Kans	360
Hawkeye Chemical Co	Clinton, Iowa	145
Hercules, Inc	Hercules, Calif	80
Do	Louisiana, Mo	500
Do	Bessemer, Ala	16
Do	Donora, Pa	137
Illinois Nitrogen Corp	Marseilles, Ill	170
International Minerals & Chemical Corp	Sterlington, La	187
Kaiser Agricultural Chemicals Co	Savannah, Ga	198
Do	Tampa, Fla	54
Do	North Bend, Ohio	96
Do	Bainbridge, Ga	48
Mississippi Chemical Corp	Yazoo City, Miss	400
Mobil Chemical Co	Beaumont, Tex	177
Monsanto Co	El Dorado, Ark	350
Do	Luling, La	275
Nipak, Inc	Kerens, Tex	71
Nitram, Inc	Tampa, Fla	132
N-Ren Corp. (Cherokee Nitrogen, Inc.)	Pryor, Okla	85
N-Ren Corp. (St. Paul Ammonia Products Co., Inc.)	Pine Bend, Minn	88
Phillipis Pacific Chemical Co	Kennewick, Wash	50
Phillips Petroleum Co	Beatrice, Nebr	68
Do	Etter, Tex	168

Table 4.—Domestic producers of ammonium nitrate—Continued
(Thousand short tons per year of NH_4NO_3)

Company	Location	Capacity
Reichhold Chemicals, Inc	St. Helens, Oreg	22
J. R. Simplot Co	Pocatello, Idaho	18
Tennessee Valley Authority	Muscle Shoals, Ala	43
Terra Chemicals International, Inc	Port Neal, Iowa	136
USS-Agri Chemicals, Inc	Crystal City, Mo	92
Do	Cherokee, Ala	90
Do	Geneva, Utah	100
Valley Nitrogen Producers, Inc	El Centro, Calif	41
Vistron Corp	Lima, Ohio	85
Wycon Chemical Co	Cheyenne, Wyo	75
Total		7,860

Source: World Fertilizer Capacity, Ammonium Nitrate. (Distribution Economics Section, Tennessee Valley Authority, Muscle Shoals, Ala., Sept. 30, 1976.)

CONSUMPTION AND USES

U.S. consumption of fixed nitrogen remained at 13.0 million short tons in 1975. Consumption of elemental nitrogen is assumed to be equal to production, because no statistics are collected on stocks and international trade is negligible.

The principal use of fixed nitrogen was in fertilizers, which consumed approximately three-fourths of production.[24] Explosives, resins, fibers, plastics, and animal feeds were among the other uses. The two major uses of elemental nitrogen were as a gas to exclude or purge air from such industrial processes as steelmaking, electronics, chemical manufacture, and glassmaking, and as a liquid to provide low temperatures in food processing and scientific applications. These cryogenic processes were estimated at 18% of total use.

PRICES

Quoted prices of most major nitrogen compounds apparently remained stable during the year, after approximately doubling during 1974. Actual prices paid by American farmers for nitrogenous fertilizers reached their highest levels during the spring of 1975. Throughout the rest of the year, however, prices exhibited a steady decline, and by yearend, prices at the farm level had decreased about 20%. Contributing factors included increased production capacity without a corresponding increase in consumption, and the resulting higher inventories.

[24] Chemical and Engineering News. Ammonia Squeeze Loosens, Outlook Stays Good. V. 53, No. 17, Apr. 28, 1975, pp. 10–13.

Table 5.—Price quotations for major nitrogen compounds in 1975
(Per short ton)

Compound	Jan. 1	Dec. 31
Ammonium nitrate, domestic, fertilizer-grade, 33.5% nitrogen, bulk, delivered	\$91–\$115	\$91–\$115
Ammonium sulfate, standard-grade, commercial, bulk, f.o.b. works	89	60
Anhydrous ammonia, fertilizer, wholesale, tanks, delivered east of Rockies, except east coast	190– 210	180– 190
Aqueous ammonia, 29.4% NH_3, anhydrous basis, tanks, freight equalized east of Rockies	165– 180	165– 180
Sodium nitrate, domestic, agricultural:		
Bulk, carlots, f.o.b. works	127	139
Bags, carlots, f.o.b. works	138	130
Sodium nitrate, imported, commercial:		
Bulk, carlots, f.o.b. Atlantic and Gulf warehouses	132	130
100-pound bags, carlot, same basis	143	141
Urea:		
Industrial, 46% nitrogen, bulk, 50-ton carlots, delivered East	160– 175	160– 175
Agricultural, 46% nitrogen, bulk, same basis	160– 175	160– 175
Agricultural, 45% nitrogen, bulk, 50-ton carlots, delivered East	160– 175	160– 175
Diammonium phosphate, fertilizer grade, 18–46–0, bulk, carlots, f.o.b. Florida works	145– 165	135

Source: Chemical Marketing Reporter.

FOREIGN TRADE

Exports of contained nitrogen increased by 20% in 1975. Exports in almost all categories were up, the exceptions being anhydrous ammonia and mixed chemical fertilizers. Exports over the period 1973–74 had declined 34%. Total imports also rose 12% in 1975. Since imports in nearly all categories were down from 1974, the overall increase was due to a sizeable increase in anhydrous ammonia imports. In 1975, as in 1974, the United States was a net importer of fixed nitrogen, in contrast to the previous decade. Fixed nitrogen imports in the period 1966–75 have increased steadily, while exports have shown a lesser, more cyclic, growth trend.

Table 6.—U.S. exports and imports for consumption of major nitrogen compounds
(Thousand short tons and thousand dollars)

Compounds	1974 Gross weight	1974 Nitrogen content [e]	1974 Value	1975 Gross weight	1975 Nitrogen content [e]	1975 Value
EXPORTS						
Industrial chemicals: Anhydrous ammonia and chemical grade aqua (ammonia content)	66	54	6,755	115	95	21,722
Fertilizer materials:						
Ammonium nitrate	18	6	2,334	46	15	6,141
Ammonium phosphates	1,992	359	358,807	2,686	484	575,897
Ammonium sulfate	530	109	35,952	715	147	46,657
Anhydrous ammonia and aqua (ammonia content)	r 332	r 272	r 42,104	185	152	21,722
Nitrogenous chemical materials n.e.c	27	8	3,473	54	16	5,616
Sodium nitrate	2	(1)	223	2	(1)	164
Urea	316	144	63,409	557	253	123,096
Mixed chemical fertilizers	474	47	53,476	324	32	40,695
Total	r 3,757	r 999	r 566,533	4,684	1,194	841,710
IMPORTS						
Industrial chemicals: Ammonium nitrate	8	3	923	3	1	451
Fertilizer materials:						
Ammonium nitrate	369	124	25,124	245	82	24,881
Ammonium nitrate-limestone mixtures	333	70	36,129	66	14	8,971
Diammonium phosphates [2]	344	62	40,509	92	16	14,112
Other ammonium phosphates				211	38	36,528
Ammonium sulfate	258	53	20,232	219	45	21,357
Calcium cyanamide or lime-nitrogen	3	(1)	503	57	12	338
Calcium nitrate	155	24	7,896	95	15	7,099
Nitrogen solutions	87	26	7,193	117	35	11,666
Anhydrous ammonia	455	373	52,205	807	662	123,932
Potassium nitrate or saltpeter, crude	14	2	1,797	36	4	7,016
Potassium nitrate, sodium nitrate mixtures	27	4	2,503	25	4	4,388
Sodium nitrate	150	24	14,356	139	22	19,100
Urea	717	326	87,870	654	298	87,899
Nitrogenous fertilizers n.s.p.f	168	34	14,387	134	27	14,407
Mixed chemical fertilizers	286	29	33,603	213	21	33,389
Total	3,374	1,154	345,230	3,113	1,296	415,534

[e] Estimate. [r] Revised.
[1] Less than ½ unit.
[2] Effective January 1, 1975; formerly part of ammonium phosphates.

WORLD REVIEW

Abu Dhabi.—Two plants for the manufacture of ammonia and urea were planned by the Abu Dhabi Government. Most of the production was slated for export to reduce the country's dependence on the oil market for revenue.[25]

Algeria.—The French affiliate of M. W. Kellogg Co. contracted with Sonatrach for a 1,100-ton-per-day ammonia plant to be built at Annaba. The new plant will be near an existing phosphate fertilizer complex. The ammonia, to be produced from natural gas, will be primarily for use in Algeria.[26]

Australia.—Western Mining Corp., Australia's largest nickel producer, was establishing its own ammonia plant with a capacity of 55,000 tons per year at Kwinana. The facility was purchased from Consolidated Fertilizers Ltd. in Queensland, then dismantled and shipped by rail to Kwinana. The company was able to buy the plant at a much lower price than it would now cost to build one, and the plant gives the company more operational independence.[27]

Bangladesh.—Ashuganj Fertilizer and Chemical Co. Ltd. announced plans to construct an ammonia-urea plant at Ashugani. The plant will produce 1,760 tons per day of urea and 1,045 tons per day of ammonia using natural gas feedstock. The International Development Association will supply part of the finance.[28]

Belgium.—Ste. Carbochimique, S.A., planned to reactivate a 71,500-ton-per-year urea plant at Willebroek by 1976, to coincide with the scheduled completion of a 363,000-ton-per-year urea facility at Tertre.[29]

Canada.—Canadian Kellogg Ltd. was constructing a 396,000-ton-per-year ammonia plant and a 495,000-ton-per-year urea unit for Canadian Fertilizers Ltd., at Medicine Hat, Alberta. The Government of Alberta approved the company's proposed construction of a second ammonia plant of similar size.[30]

The Alberta Energy Resources Conservation Board approved proposals for two more ammonia plants. Alberta Ammonia Ltd. planned to construct a 616,000-ton-per-year facility at Raymond. The bulk of its production will be piped to Farmland Industries, Inc., of the United States. The company also applied for permission to build a second ammonia unit of similar size. The other project was a joint venture by Pan Canadian Petroleum Ltd. and the Tyler Corp. of Texas for a 310,000-ton-per-year plant at Brooks. Most of this plant's production was intended for export to the United States also.[31] Beker Industries Corp. reopened a renovated 179,000-ton-per-year ammonia plant at Sarnia, Ontario.[32]

China, People's Republic of.—The People's Republic of China produced an estimated 3 to 4 million tons of contained nitrogen in 1975. Thirteen large nitrogen-fertilizer plants have been contracted for or are presently under construction. In addition, there is a program to build numerous small plants. These facilities could push nitrogen-fertilizer production to 9 to 11 million tons of contained nitrogen by 1980.[33]

Cuba.—A considerable expansion was underway in Cuban ammonia and nitrogen fertilizer capacity. Unión Explosivos Rio Tinto, S.A. Spain's largest chemical manufacturer, finalized a contract to construct in Cuba a 1,100-ton-per-day ammonia plant with downstream urea and complex fertilizer units at an estimated cost of $120 million. In addition, the U.S.S.R. was assisting in the construction of ammonia, urea, ammonium nitrate, and nitric acid production facilities, which were scheduled for completion in 1976 at Nuevitas.[34]

Egypt.—Foster Wheeler Italiana was awarded a contract to build a 1,320-ton-per-day ammonia plant and a 1,900-ton-per-day urea plant at Talkhā. Both were scheduled to come on stream in 1978.[35]

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[25] New York Times. Abu Dhabi Plans 2 Fertilizer Plants to Make Exports, Not Deserts, Bloom. Dec. 29, 1975, pp. 47, 49.

[26] Chemical Marketing Reporter. From the Cable Desk: Ammonia (Algeria). V. 207, No. 7, Feb. 17, 1975, p. 9.

[27] Chemical Age. Australia Plans Ammonia Unit. V. 110, No. 2915, May 30, 1975, p. 11.

[28] European Chemical News. New Ammonia/Urea Unit for Bangladesh. V. 27, No. 676, Feb. 28, 1975, p. 10.

[29] Page 13 of work cited in footnote 19.

[30] First work cited in footnote 10.

[31] Fertilizer International. Approval for Alberta Ammonia Plants at Last. No. 72, June 1975, pp. 1, 3.

[32] Work cited in footnote 19.

[33] Wang, K. P. Mineral Resources and Basic Industries in the People's Republic of China. Westview Press, Boulder, Colorado, 1977, 225 pp.

[34] Fertilizer International. Cuba Set for Massive Nitrogen Expansion. No. 70, April 1975, p. 1.

[35] Page 21 of first work cited in footnote 12.

El Salvador.—A 163,000-ton-per-year ammonium sulfate plant was brought onstream at the port of Acajutla.[36]

France.—French chemical companies launched a major investment program in ammonia production to meet France's growing needs. The Industry Minister authorized construction of five units, which would increase capacity by more than 1 million tons, for a total capacity of nearly 4 million tons per year. Cie. Française de l'Azote scheduled a 1,100-ton-per-day plant at Bordeaux; Société Chemique des Charbonnages (CdF Chimie), Grand Paroisse, and Produits Chimiques Ugine Kuhlmann formed a consortium to build a 1,100-ton-per-day unit at Villiers-St. Paul; Rhone-Poulenc S.A. and CdF Chimie have planned a joint venture of 1,100 tons per day at Rouen; Ste. Gardinier announced a 660-ton-per-day facility at Montoir-de-Bretagne; Grande Paroisse proposed the expansion of its ammonia plant at Waziers by 165 tons per day. Since 1973, French ammonia consumption has exceeded production. Without expansion, imports could have reached 550,000 to 990,000 tons by 1977 and 1.1 to 1.9 million tons by 1980.[37] The Government guaranteed natural gas supplies but refused to make any commitment to increase French ammonia prices.

Germany, East.—A 495,000-ton-per-year ammonia plant, designed by M. W. Kellogg Co. and constructed by Toyo Engineering Corp., came onstream at Piesteritz in September.[38]

Germany, West.—Construction of a 1,700-ton-per-day ammonia plant and a 1,000-ton-per-day urea plant in the Brunsbuttel area was announced by Veba Chemie AG and the Danish firm Superfos A/S. Both units were expected onstream in 1978.[39]

Greece.—Aeval, S.A., operator of the Government-owned nitrogenous fertilizer plant at Ptolemaís, planned the establishment of a 1,320-ton-per-day anhydrous ammonia unit and awarded the British firm of Humphrey-Glasgow the contract for preparation of a feasibility study. The new unit was slated to use Ptolemaís lignite as raw material.[40]

Hungary.—Petfurdo Nitrogen Works commissioned a new ammonia plant at Várpalota. The plant, which was designed by M. W. Kellogg, has a capacity of 300,000 tons per year of ammonia. A connecting urea plant, with a capacity of 100,000 tons per year of contained nitrogen, was also placed onstream in 1975.[41]

India.—The Government of India accorded the highest priority for fertilizer production facilities in an effort to achieve increased production and improved utilization of existing capacity. Construction of a fertilizer plant at Phulpur for the production of 990 tons per day of ammonia and 1,650 tons of urea per day was approved. The unit will be owned and operated by the Indian Farmers Fertilizer Cooperative Ltd. (IFFCO) and will utilize heavy fuel oil as feedstock and coal for steam and power generation.[42] In addition, IFFCO brought a 430,000-ton-per-year urea plant onstream at Kolol.[43]

The second ammonia and urea units at Namrup were brought onstream with capacities of 218,000 and 363,000 tons per year, respectively. Feedstock was natural gas from upper Assam oilfields. The Barauni fertilizer plant, consisting of a 220,000-ton-per-year ammonia unit and a 363,000-ton-per-year urea facility, was expected to be onstream in December. The Gujarat State Fertilizers Co. Ltd. was slated to receive a loan from West Germany for construction of a 490,000-ton-per-year ammonia plant and a 580,000-ton-per-year urea unit. The construction of four coal-based ammonia plants located in Madhya Pradesh and at Korba, Talcher, and Ramagundan have been approved. The latter two, designed by Montedison, were under construction by the Fertilizer Corp. of India Ltd. and were due onstream in 1977–78. Capacities will be 327,000 tons per year of ammonia and 690,000 tons per year of urea.[44]

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[36] Pages 18–19 of first work cited in footnote 10.

[37] Chemical Age. French Ammonia Firms Plan £200 M Expansion. V. 110, No. 2905, Mar. 21, 1975, p. 14.
Fertilizer International. 1 Million T.P.A. Boost to French Ammonia Capacity. No. 70, April 1975, p. 1.

[38] First work cited in footnote 10.

[39] Chemical Marketing Reporter . Fertilizer Plants Slated by West German Firm. V. 208, No. 10, Sept. 8, 1975, p. 17.

[40] European Chemical News. Humphrey & Glasgow Wins Greek Ammonia Plant Study. V. 27, No. 112, Nov. 21, 1975, p. 50.
U.S. Embassy, Athens, Greece. State Department Airgram A-214, Nov. 21, 1975, 4 pp. w/encl.

[41] European Chemical News. Hungary Commissions New Ammonia Plant. V. 27, No. 711, Nov. 14, 1975, p. 14.

[42] U.S. Embassy, New Delhi, India. State Department Airgram A-92, Mar. 11, 1975, 9 pp. w/encl.

[43] Work cited in footnote 15.

[44] Page 19 of first work cited in footnote 10.

Construction of the Nagarjuna Fertilizers Ltd. facilities at Kakinada was due to begin. The plans encompassed a 330,000-ton-per-year ammonia unit together with urea and complex fertilizer facilities. The complex was due onstream in 1979. Southern Petrochemical Industries Corp. Ltd. brought a 578,000-ton-per-year urea plant onstream at Tuticorin in late June. The associated naphtha-based ammonia plant entered production earlier in the year. A 363,000-ton-per-year urea plant was under construction at the Sindri complex of the Fertilizer Corporation of India.[45]

Part of a $17 million World Bank loan was to be spent on converting the Neyveli Lignite Corp. Ltd.'s 103,000-ton-per-year ammonia plant to naphtha operation.[46] Maharashta Co-operative Chemicals & Fertilizers Ltd. signed an $8 million contract with Haldor Topsoe of Denmark for the construction of an integrated ammonia and ammonium chloride plant at Tarapur. The facility was due onstream in 1977–78.[47]

Indonesia.—Indonesia planned to increase nitrogen fertilizer capacity to about 1.6 million tons per year with the third expansion of the complex at Palembang. P. T. Pupuk Sriwidjaja (PUSRI), the Indonesian petrochemical company, named Kellogg Overseas Corp. as contractor for a new complex, PUSRI IV, which would consist of a 1,100-ton-per-day ammonia plant and a 1,900-ton-per-day urea unit. PUSRI's original 110,000-ton-per-year urea plant at Palembang was built in 1959. PUSRI II, the 1974 expansion of the facility, consisted of a 725-ton-per-day ammonia plant and a 1,265-ton-per-day urea facility. PUSRI III, scheduled for completion in 1977, will provide 1,100 tons per day of ammonia and 1,900 tons per day of urea capacity.[48]

Iraq.—The Mitsubishi Group gained a major fertilizer plant contract from the Iraqi Government's Ministry of Industry for the construction of a 550,000-ton-per-year ammonia plant and a urea unit with an output of over 1 million tons per year at Khor al-Zubair.[49]

Ireland.—Nitrigin Eireann Teoranta awarded Kellogg International Corp. a contract for a nitrogen fertilizer complex at Marino Point. The 1,485-ton-per-day ammonia plant, 1,100-ton-per-day urea plant, and associated off-site developments were scheduled for completion in early 1978.[50]

Japan.—Ube Industries Ltd. planned to increase the capacity of its ammonia plant at Ube City by 275 tons per day by year-end 1975. Mitsubishi Gas Chemical Co. Ltd. decided to construct an 880-ton-per-day ammonia unit at Niigata beginning in 1976.[51]

Kuwait.—Kuwait Petrochemical Industries Co. awarded a contract to S.A. Coppee-Rust N.V. of Belgium to increase capacity of a urea plant at Shuaiba from 645 to over 1,100 tons per day.[52]

Libya.—Discussions continued on the addition of further fertilizer plants to the Marsa el Brega complex. Plans included the construction of another 1,100-ton-per-day ammonia plant, due onstream in 1978, and a 2,970-ton-per-day urea plant.[53]

Malaysia.—An $800 million petrochemical complex, including a 495,000-ton-per-year urea plant, was planned by Petronas Malaysia.[54]

Mexico.—Guanos y Fertilizantes S.A. planned a new fertilizer plant at San Juan del Rio, to include a 330,000-ton-per-year ammonium sulfate facility.[55] A 1,650-ton-per-day ammonia plant was scheduled at Coatzacoalcos, and a 1,100-ton-per-day unit was slated to come onstream at Bajío in early 1977.[56]

Netherlands.—The 740,000-ton-per-year ammonia capacity of the Sluiskil works was scheduled for a 50% expansion. A new ammonia plant with a capacity of 485,000 tons per year was planned for Geleen.[57]

Nigeria.—The Nigerian Government announced a feasibility study for two ammonia-urea complexes at Warri and Port Harcourt. The plants would be designed to utilize natural gas and refinery tail gases, which are currently flared. There are no

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[45] Nitrogen. New Plants and Projects. No. 97, September/October 1975, p. 15.
[46] Work cited in footnote 18.
[47] Page 16 of work cited in footnote 19.
[48] Oil & Gas Journal. Indonesian Fertilizer Capacity Due Big Hike. V. 73, No. 33, Aug. 18, 1975, p. 50.
[49] Chemical Age. Mitsubishi Win Iraqi NH_3 Plant. V. 111, No. 2930, Sept. 12, 1975, p. 15.
[50] Page 13 of work cited in footnote 19.
[51] Page 16 of work cited in footnote 19.
[52] Work cited in footnote 45.
[53] European Chemical News. More Fertilizer Plants Planned in Libya. V. 27, No. 696, July 25, 1975, p. 14.
[54] Page 20 of first work cited in footnote 10.
[57] Page 13 of work cited in footnote 45.
[56] Page 19 of work cited in footnote 18.
[57] Page 13 of work cited in footnote 45.

nitrogen fertilizer facilities presently in Nigeria.[58]

Pakistan.—Snamprogetti reached agreement with the National Fertilizer Corp. of Pakistan for the construction of a $193 million, 363,000-ton-per-year ammonia unit and a 633,000-ton-per-year urea plant at Mirpur Mathels. Haripur was named as the location for a fertilizer project originally announced for the Peshawar area. Capacities for the ammonia and urea plants were 187 and 330 tons per day, respectively.[59]

Peru.—On April 19, 1975, Petroperú inaugurated the Talara fertilizer complex, which was built by Toyo Engineering Corp. of Japan at a cost of $44.2 million. The facility will produce 300 tons of ammonia and 510 tons of urea daily.[60]

Romania.—The Romanian state corporation, Romchim, accepted delivery of a 1,100-ton-per-day ammonia plant designed by M. W. Kellogg Co. at Tirgu-Mures. It was the first of six Kellogg plants slated for Romania. The others are proposed for Turnu-Magurele in 1976, Craiova in late 1976 or 1977, Arad and a second unit at Tirgu-Mures in 1977, and Tecuci.[61] A massive fertilizer complex to be financed by the World Bank was scheduled for construction at Bacau. Several of the plants will be duplicates of existing Romanian operations, but the urea unit to be built by Coppee-Rust will have an increased capacity of 462,000 tons per year. The entire complex, which also includes a major power station, is due to be completed in mid-1978.[62]

Saudi Arabia.—Petromin, the Government's minerals company, planned the construction of three large-scale nitrogenous fertilizer export plants. Two of the projects, with the U.S. firm Agrico Chemical Co. and the Taiwan Fertilizer Co., were joint ventures, but the third was wholly owned by Petromin, although carried out in association with Britain's ICI.[63]

Senegal.—Fertisen S.A. announced plans to build a 36,000-ton-per-year ammonia plant and a 55,000-ton-per-year urea unit at M'Bao near Dakar. The facility was scheduled for completion in 1977.[64]

South Africa, Republic of.—African Explosives and Chemical Industries, Ltd., started up its Rand coal-based ammonia plant at Modderfontein. The 1,100-ton-per-day unit formed the major part of the nitrogen project there.[65] Construction of a 825-ton-per-day urea plant by Kellogg Continental B.V. was also nearing completion.[66] A new chemicals-from-coal complex, which included a 110,000-ton-per-year ammonia plant was scheduled for completion in the Transvaal by 1981.[67]

Spain.—Kellogg International Corp., London, in cooperation with Tecnicas Reunidas, was engineering the Sefanitro S.A. 1,090-ton-per-day ammonia plant, which was scheduled for completion at Bilbao in 1977. The naphtha-fed plant was being designed for conversion to gas feedstock when gas becomes available.[68] A 990-ton-per-day ammonia plant using naphtha feedstock was scheduled for startup at Huelva in late summer. A new urea plant was slated for completion by Toyo Engineering Corp. at the same site in 1976.[69]

Sri Lanka.—The Fertilizer Manufacturing Corp. has planned a $163 million fertilizer complex at Hapugaskanda, including a 165,000-ton-per-year ammonia unit and a 330,000-ton-per-year urea plant, due onstream in 1978.[70]

Syria.—On October 1, 1975, a contract was signed between Unichem and Creusot-Loire Enterprises of France for the installation of a refinery and nitrogen fertilizer complex at Homs. The Kellogg-designed-and-engineered ammonia plant will produce 1,100 tons per day, and the Heurtey Industries-engineered urea unit will generate 1,150 tons per day. Naphtha from the refinery will be used as feedstock.[71]

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[58] Fertilizer International. Nigeria To Build Ammonia Complex? No. 76, October 1975, pp. 1, 7.
[59] Page 20 of work cited in footnote 18.
[60] U.S. Embassy, Lima, Peru. State Department Airgram A-78, May 9, 1975, 2 pp.
[61] Chemical Week. Rumanian Ammonia Buildup Is Under Way. V. 116, No. 14, Apr. 2, 1975, p. 22.
[62] European Chemical News. Romania Places Contracts for Massive Fertilizer Complex. V. 27, No. 716, Dec. 19/26, 1975, p. 34.
[63] U.S. Embassy, Beirut, Lebanon. State Department Airgram A-126, May 19, 1975, 6 pp. w/encl.
[64] Page 19 of first work cited in footnote 10.
[65] European Chemical News. AE&CI Starts Up Big Ammonia Unit. V. 26, No. 669, Jan. 10, 1975, p. 16.
[66] Work cited in footnote 45.
[67] Page 16 of work cited in footnote 19.
[68] Chemical Marketing Reporter. Ammonia Plant in Spain Is Designed by Kellogg. V. 207, No. 11, Mar. 17, 1975, p. 53.
European Chemical News. Kellogg Engineers Spanish Ammonia Plant. V. 27, No. 672, Jan. 31, 1975, p. 12.
[69] Pages 13–14 of work cited in footnote 45.
[70] Page 20 of first work cited in footnote 10.
[71] European Chemical News. Creusot-Loire Wins Syrian Ammonia Order. V. 27, No. 706, Oct. 10, 1975, p. 16.

Taiwan.—Ammonia capacity at the Nankong plant of Taiwan Fertilizer Co. has been expanded to 66,000 tons per year. Kellogg Continental was awarded a contract for a 327,000-ton-per-year ammonia unit and a 218,000-ton-per-year urea plant, due for completion at yearend 1977.[72]

Trinidad and Tobago.—Kaiser Aluminum & Chemical Corp. agreed to build a $150 million fertilizer complex. In addition to 1,100 tons per day of ammonia, the plant would also produce liquid urea, nitric acid, and ammonium nitrate. Most of the product would be exported to the United States.[73]

U.S.S.R.—Construction was begun at Kemerovo on the first of two ammonia units with a capacity of 404,000 tons per year of contained nitrogen. Creusot-Loire Enterprises of France was building the plant, using a Kellogg process design. Both units were due onstream in 1978.[74] Toyo Engineering Corp. of Japan won a $350 million contract with the U.S.S.R. to supervise the construction of four 1,485-ton-per-day ammonia plants and two 1,650-ton-per-day urea units over a 4-year period.[75] Russian shipbuilders launched the first of seven tankers slated to haul liquid ammonia from the U.S.S.R. to the United States and return with superphosphoric acid. The tankers are being built under a 1973 agreement with Occidental Petroleum Corp., and are expected to be afloat by 1980.[76] Snamprogetti was awarded contracts for three 495,000-ton-per-year urea plants to be built at unspecified locations, probably by 1978. At least two of the plants will be integrated with ammonia units which have been ordered from Snamprogetti.[77] Two large scale ammonia plants were scheduled for completion in 1976 at the Grodno nitrogen complex. The new units will more than triple the existing capacity of 396,000 tons of contained nitrogen. Urea and ammonium sulfate plants were also under construction at the site.[78]

United Kingdom.—The decision to construct a 300-ton-per-day liquid oxygen-nitrogen plant near Glasgow, Scotland, at a total investment of about $11.7 million was announced by the British subsidiary of Air Products & Chemicals, Inc. The plant was scheduled for completion in 1977, and will provide for anticipated industrial growth in Scotland and northern England.[79]

Vietnam, North.—The Hitachi Shipbuilding Co. of Japan reached agreement with the North Vietnamese Government for the construction of a 132,000-ton-per-year nitrogen fertilizer plant.[80]

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[72] Page 20 of first work cited in footnote 10.
[73] Chemical Week. New Latin American Fertilizer Projects Are Emerging. V. 116, No. 5, Jan. 29, 1975, p. 23.
[74] Work cited in footnote 16.
[75] Fertilizer International. Toyo in Ammonia Plant Deal with U.S.S.R. No. 70, April 1975, p. 1.
[76] Chemical Week. Russia Launches Ammonia Tanker for U.S. Trade. V. 117, No. 19, Nov. 5, 1975, p. 51.
[77] Work cited in footnote 19.
[78] Page 19 of first work cited in footnote 12.
[79] American Metal Market. V. 82, No. 90, May 8, 1975, p. 2.
[80] Fertilizer International. Plant & Project News. No. 70, April 1975, p. 10.

Table 7.—Fertilizer nitrogen compounds: World production and consumption for years ended June 30, by country

(Thousand short tons of contained nitrogen)

Country	Production			Consumption		
	1972–73	1973–74	1974–75 [p]	1972–73	1973–74	1974–75 [p]
North America:						
Canada	851	885	882	452	565	562
Costa Rica	18	30	33	[e,1] 29	[e,1] 37	[e,1] 44
Cuba	2	22	6	[1] 114	144	154
Dominican Republic	--	--	--	46	45	51
El Salvador [e]	2	8	8	72	75	69
Guatemala	--	--	--	4	4	3
Mexico	393	414	451	519	586	745
Netherlands Antilles [e]	20	7	23	--	--	--
Trinidad and Tobago [e,2]	126	74	100	8	8	6
United States (includes Puerto Rico)	9,296	10,095	9,503	8,295	9,157	8,593
South America:						
Argentina	42	32	39	54	48	61
Brazil [1]	87	126	165	454	383	411
Chile [1]	[e] 119	[e] 118	[e] 125	58	65	57
Colombia [1]	85	95	99	125	170	140
Ecuador [e]	2	2	2	22	32	36
Peru [3]	25	23	22	110	89	125
Venezuela [1]	11	7	53	40	45	55
Europe:						
Albania [e,1]	40	40	40	36	40	40
Austria	253	254	249	150	146	138
Belgium	704	719	705	184	182	198
Bulgaria [1]	577	572	654	390	362	363
Czechoslovakia	[e,1] 451	[e,1] 456	[e,1] 533	517	455	472
Denmark [4]	85	92	92	363	402	331
Finland	268	269	280	198	228	250
France	1,628	1,810	1,867	1,751	2,021	1,714
Germany, East [1]	472	453	481	725	734	740
Germany, West	1,621	1,624	1,735	1,311	1,213	1,324
Greece	265	290	292	234	269	277
Hungary [1]	412	468	459	465	543	608
Iceland [1]	9	11	8	15	16	15
Ireland	[e] 93	[e] 104	[e] 107	145	144	147
Italy	1,152	1,245	1,247	763	741	741
Luxembourg [e]	2	2	2	14	15	17
Netherlands	1,341	1,324	1,421	415	454	476
Norway	436	490	430	87	94	106
Poland	[1] 1,265	[1] 1,505	[1] 1,607	1,079	1,184	1,264
Portugal	[e] 165	181	142	[e] 144	141	140
Romania [1]	963	941	1,080	464	487	540
Spain [1]	798	841	903	760	803	787
Sweden [5]	187	197	194	257	290	259
Switzerland	29	29	32	43	46	42
U.S.S.R.[1]	7,221	7,982	8,660	6,185	6,900	7,441
United Kingdom [5]	828	833	975	870	964	1,012
Yugoslavia [1]	397	386	409	375	374	388
Africa:						
Algeria [e]	55	57	87	94	103	79
Egypt	[e,1] 167	[e,1] 56	[e,1] 110	[6] 398	[6] 395	[6] 397
Ivory Coast [e,1]	7	5	7	10	9	9
Kenya	--	--	--	20	22	21
Morocco [1]	13	16	17	59	69	79
Mozambique	[e] 10	9	3	[e] 8	10	4
Rhodesia, Southern [e]	64	66	72	66	77	83
Senegal	10	10	6	6	8	10
South Africa, Republic of [e,1]	273	283	279	279	255	278
Sudan [e]	--	--	--	97	77	77
Tanzania [1]	[e] 2	[e] 2	7	9	12	12
Tunisia [e]	--	--	--	17	21	26
Zambia	[e] 8	5	4	[e] 28	26	33
Asia:						
Bangladesh	102	143	36	143	140	91
Burma	40	40	48	35	40	42
China, People's Republic of [e,1,7]	2,226	2,830	3,131	3,569	4,191	4,037
India	1,162	1,157	1,308	1,960	2,016	1,955
Indonesia	66	94	144	383	386	443
Iran	157	144	144	136	214	274
Iraq	29	31	36	[e] 17	22	30
Israel	26	35	43	37	33	36
Japan	2,424	2,357	2,580	808	905	761

See footnotes at end of table.

Table 7.—Fertilizer nitrogen compounds: World production and consumption for years ended June 30, by country—Continued

(Thousand short tons of contained nitrogen)

Country	Production			Consumption		
	1972–73	1973–74	1974–75 p	1972–73	1973–74	1974–75 p
Asia—Continued:						
Korea, North e 1	254	265	276	248	269	278
Korea, Republic of	[1] 461	[1] 493	[1] 566	411	453	493
Kuwait	297	320	304	--	--	--
Lebanon e	3	--	--	36	43	21
Malaysia	e 44	e 51	e 55	89	123	137
Pakistan	302	331	343	426	367	396
Philippines e	[1] 61	[1] 59	[1] 59	126	167	196
Saudi Arabia	76	67	89	e 2	e 4	e 6
Sri Lanka	--	--	--	60	56	85
Syria	17	10	17	36	37	30
Taiwan 8	249	247	276	244	235	287
Thailand	[1] 8	[1] 8	[1] 7	e 68	66	88
Turkey 1	160	149	119	407	474	422
Vietnam, North e 1	--	--	--	12	22	23
Vietnam, South e 1	--	--	--	165	91	110
Oceania: Australia e	201	217	217	182	194	195
Other:						
North and Central America 9	--	--	--	82	101	90
South America 10	--	--	--	37	34	34
Europe 11	--	--	--	2	2	2
Africa 12	--	--	--	118	114	115
Asia 13	--	--	--	49	58	51
Oceania 14	--	--	--	45	46	34
World total	41,715	44,613	46,505	39,366	42,688	42,807

e Estimate. p Preliminary.

1 Calendar year referring to the first part of the split year.

2 Excludes nitrogen content of anhydrous ammonia produced for export in that form for subsequent processing elsewhere.

3 Production of guano only.

4 Fertilizer year: August-July.

5 Fertilizer year: June-May.

6 Fertilizer year: November-October.

7 United States Bureau of Mines estimate based on United Nations estimate for the People's Republic of China and Taiwan (reported as a single figure) less the British Sulphur Corp. Ltd. reported figure for Taiwan alone.

8 Source: The British Sulphur Corporation Ltd. (London), Statistical Supplement No. 12, November-December 1975, pp. 14–15.

9 Includes Barbados, Belize, Guadeloupe, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, St. Kitts, Nevis and Anguilla, St. Lucia, and St. Vincent.

10 Includes Bolivia, Guyana, Paraguay, Surinam, and Uruguay.

11 Includes Channel Islands and Isle of Man.

12 Includes Angola, Botswana, Burundi, Cameroon, Central African Republic, Chad, Congo, Dahomey, Equatorial Guinea, Ethiopia, Gambia, Ghana, Guinea, Liberia, Libya, Malagasy Republic, Malawi, Mali, Mauritius, Niger, Nigeria, Reunion, Rwanda, Sierra Leone, Somalia, Swaziland, Togo, Uganda, Upper Volta and Zaire.

13 Includes Afghanistan, Cyprus, Jordan, Khmer Republic, Laos, Mongolia, Nepal, and Singapore.

14 Includes Fiji Islands, New Zealand, and Papua New Guinea.

Source: Statistical Office of the United Nations, Statistical Yearbook, 1975 (New York, 1976, pp. 298–299, 596–598) unless otherwise specified.

TECHNOLOGY

Johns Hopkins University scientists were developing a method to make ammonia from air and water on floating platforms by using power produced by tapping the temperature gradient of the oceans. The ammonia plant would be assembled on the ocean thermal energy conversion platform as an adjunct to a hydrogen-producing electrolysis unit. The source of nitrogen for the ammonia synthesizer would result from combining the oxygen in air with about one-seventh of the gaseous hydrogen from the electrolysis plant to form water. The remaining nitrogen and hydrogen are mixed and fed to the synthesizer. A condenser removes most of the ammonia as liquid, and the remaining gases are returned to the synthesizer by a recirculating compressor. A working fluid, such as ammonia, is alternately evaporated by warm surface water and condensed by colder water from the depths. In the vapor form, the working fluid powers the turbines.[81]

New ideas for boosting ammonia plant efficiency were getting intensive study because of rising prices and dwindling supplies of gas. The studies included recovery of purge gases as well as hydrogen from purge gases in the ammonia synthesis loop with cryogenic units; improved insulation materials, particularly for reforming furnaces to reduce maintenance and operating downtime relative to refractory brick; and increased use of computers to closely monitor the hydrogen-to-nitrogen ratio and improve the control of other variables.[82]

Officials of Union Carbide Corp. claimed that its metal-passivating process, used to inhibit corrosion in plants that use monoethanolamine for scrubbing carbon dioxide from synthesis gas streams, could save several hundred thousand dollars annually in an average 1,000-ton-per-day ammonia plant. A number of ammonia and hydrogen plants have converted to the system.[83]

Investigators have been searching for new ways to produce fixed nitrogen by extending or imitating the natural process. A new understanding of the nitrogenase and glutamine synthetase cycles has resulted in some interesting research, including manipulation of these enzymes and the genes that control nitrogen fixation, and indirectly improving nitrogen fixation through improvement of the photosynthesis process by controlling the supply of nutrients.[84]

The government of West Germany will provide funds for a 5-year international program of research into the use of nitrogen fertilizers. Particular attention will be focused on the possible harmful effects they might have on water supplies and food produced, with the hope that optimum application rates can be determined. The research will be carried out in West Germany in conjunction with the International Atomic Energy Organization and many research institutes in developing countries.[85]

The possibility was raised that man's increasing use of chemical nitrogen fertilizers is a greater threat to the ozone layer than chlorofluorocarbon sprays. The amount of ozone, which is formed by ultraviolet rays striking oxygen molecules, is kept in check by nitrogen compounds which act to break up ozone and cause oxygen to reform. The natural release of nitrous oxide and nitrogen by decayed matter replenishes atmospheric nitrogen and supplies the ozone-destroying catalyst. The natural denitrification process could be sharply increased with escalating use of nitrogen fertilizers, thus possibly diminishing ozone.[86]

Because of declining and unsure supplies of natural gas, The Fertilizer Institute called for a 10-year study of ammonia production by coal gasification, to be funded by the National Fertilizer Development Center of the Tennessee Valley Authority. The principal effort would be to improve the economics of the coal-based route since the cost of a 1,000-ton-per-day plant was estimated at $215 million.[87]

The city council of Seattle, Wash., was considering a $30 million, 140,000-ton-per-year ammonia plant, to be built and operated by Coyne Chemical Co., which would utilize municipal solid wastes. The city would be required to build the needed $55 million, 550,000-ton-per-year solid waste processing facility.[88]

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[81] Chemical Week. Charting New Course for Ammonia Plants. V. 117, No. 12, Sept. 17, 1975, pp. 37, 38.

[82] Chemical Week. Ammonia Plants Seek Routes to Better Gas Mileage. V. 116, No. 8, Feb. 19, 1975, p. 29.

[83] Chemical Marketing Reporter. Ammonia Aid of Carbide Said To Produce Savings. V. 207, No. 11, Mar. 17, 1975, p. 7.

[84] Science News. Improving Nitrogen Fixation. V. 108, No. 20, Nov. 15, 1975, pp. 314, 315.

[85] Fertilizer International. Nitrogen Fertilizers and the Environment. No. 69, March 1975, p. 9.

[86] Chemical and Engineering News. Nitrogen Fertilizers May Endanger Ozone. V. 53, No. 47, Nov. 24, 1975, p. 6.

Wall Street Journal. Earth's Ozone Shield May Be Imperiled by More Fertilizer Use, Scientist Says. Nov. 13, 1975.

[87] Chemical Week. Fertilizer Institute Asks Program to Develop Ammonia from Coal. V. 117, No. 9, Aug. 27, 1975, p. 9.

[88] Chemical Week. Odds Favor Ammonia. V. 117, No. 11, Sept. 10, 1975, p. 18.

Peat

By Donald P. Mickelsen [1]

Peat production in the United States in 1975 was 6% greater than in 1974, principally because of greater output by several of the smaller producers and an increase in the number of active operations. There were seven new operations in 1975, even though several producers were prevented from operating owing to a lack of environmental permits. Production increased in 11 States, with the largest production gains occurring in Florida, New York, Iowa, Colorado, and Massachusetts.

Commercial sales of peat in the United States were 6% higher than in 1974. The quantity of peat sold was 3% less than the amount produced because approximately 26,000 tons went into producers stockpiles. The total value of peat sold, f.o.b. plant, rose 12% to $12.3 million in 1975. The average value of all peat sold increased $0.93 per ton, principally because of higher production costs and a trend to packaging in smaller bags.

Imports dropped more than 11% in 1975. Still, imported peat provided 28% of the peat available for consumption in the United States. Canada provided 98% of the imported peat.

World production was estimated at 223 million tons. The U.S.S.R. was the largest producer, with an output estimated at 211 million tons, or 95%, of the world total.

DOMESTIC PRODUCTION

Peat is broadly classified in the United States as moss peat, reed-sedge peat, and humus, varying according to the type of plant matter from which it was formed and its degree of decomposition. Moss peat is a type that has been formed principally from sphagnum, hypnum, and/or other mosses; reed-sedge peat originated mainly from reeds, sedges, and other swamp plants; and humus peat is too decomposed for identification of its biological origin.

The 41,000-ton increase in 1975 production resulted from a larger output of moss-type peat. Of the reported production, more than 54% was reed-sedge peat, 25% was moss peat, and the remainder was humus.

A 48% increase in the production of moss peat was attributed to the entry of five new producers and an increased output by existing producers in Florida, Colorado, Indiana, Massachusetts, and Washington. This increase offset a 6% decrease in reed-sedge production.

Peat was produced in 22 States in 1975. Michigan remained the largest producer, with 32% of the Nation's output, followed by Florida, Illinois, Indiana, Iowa, and Colorado, ranked in the order named. These States, together with Michigan, accounted for 75% of the total production.

Active operations in the United States increased from 102 to 109, but the average output per plant decreased slightly to 7,080 tons. Over three-fourths of the operations had outputs below the average. Only 32 plants had production in excess of 5,000 tons, and only 5 plants produced more than 25,000 tons.

Production methods used in the United States varied with the size and conditions of the bog being worked. Almost all peat was harvested using conventional earthmoving and excavating machinery, or modified conventional machinery. Power shovels, bulldozers, and front-end loaders were used in drained bogs; draglines, clam

[1] Mineral specialist, Division of Coal.

shells, and dredges were used in submerged deposits.

Peat bogs are generally covered with water, tree trunks, limbs, and other debris and must be properly cleared and drained before harvesting. In most instances, the bog is drained by constructing a series of feeder ditches and collecting canals so that the prevailing water table can be lowered and controlled. Since the surface of a peat bog is unstable, roads are built across the bog to provide a firm surface for trucks to travel on. The use of special wide-track treads enables other machinery to operate upon the bog surface.

Various harvesting techniques are employed at domestic peat operations. Generally, the peat is harvested by first loosening the top layer of the bog to a depth of approximately one-half inch with a disk, spike, or spring harrow. The loosened peat is then scraped into piles alongside the roads with bulldozers and loaded into trucks with front-end loaders. Other production methods include the use of vacuum harvesters, snowblowing machines, draglines, and dredges.

Peat is usually processed for sale by air drying, shredding, screening and in a few instances, by artificial drying. Processing equipment consists of a variety of screens, shredders, grinders, hammermills, and gas- and oil-fired dryers.

In 1975, 37% of the peat was sold as produced with no processing other than air drying. About 62% was shredded, but only 1% was subjected to thermal drying.

Table 1.—Salient peat statistics

	1972	1973	1974	1975
United States:				
Number of operations	103	98	102	109
Production .... short tons	576,712	634,503	731,004	771,716
Commercial sales .... do	606,679	620,583	705,995	745,636
Value .... thousands	$7,112	$7,547	$10,989	$12,294
Average per ton	$11.72	$12.16	$15.56	$16.49
Imports .... short tons	310,521	323,501	326,530	290,358
Available for consumption[1] .... do	917,200	944,084	1,032,525	1,035,994
World: Production .... thousand short tons	221,143	r 220,145	r 220,695	223,327

r Revised.
[1] Commercial sales plus imports.

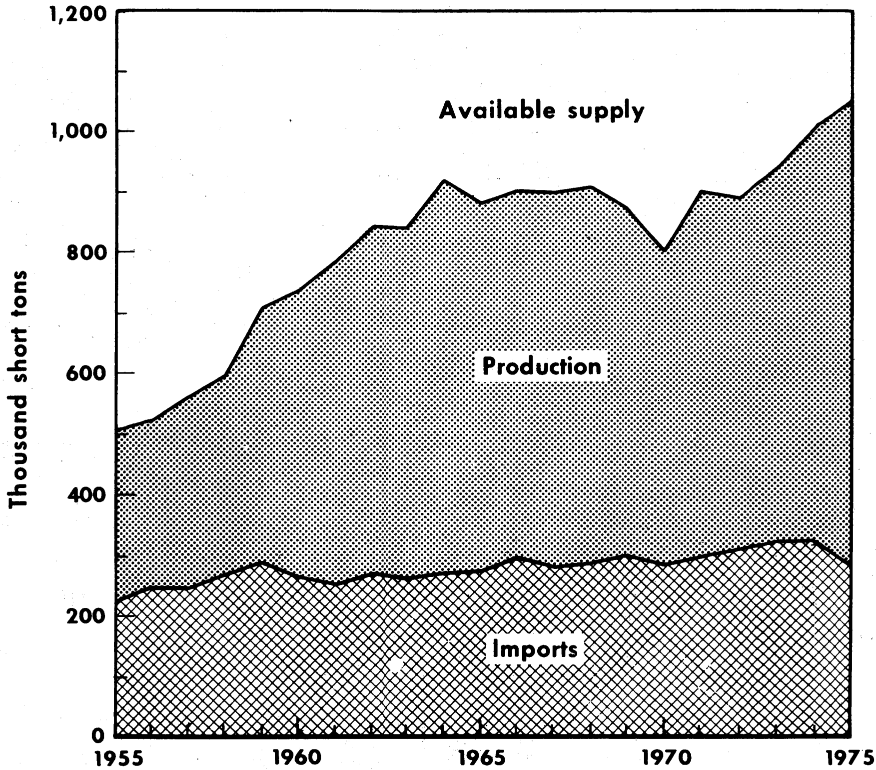

Figure 1.—Production, imports, and available supply of peat in the United States.

Table 2.—Peat produced in the United States in 1975, by kind
(Short tons)

Kind	Unprocessed	Processed			Total
		Shredded	Kiln-dried only	Shredded and kiln-dried	
Moss	72,379	115,882	--	3,654	191,915
Reed-sedge	181,746	236,379	--	580	418,705
Humus	35,057	124,616	1,105	318	161,096
Total	289,182	476,877	1,105	4,552	771,716

Table 3.—Production and commercial sales of peat in the United States in 1975, by State

State	Active plants	Production (short tons)	Commercial sales: Quantity (short tons)	Value: Total (thousands)	Value: Average per ton
Colorado	10	39,524	36,937	$280	$7.57
Florida	9	100,895	81,528	1,037	12.72
Georgia	2	378	378	5	13.18
Illinois	6	96,295	95,719	1,511	15.79
Indiana	9	52,814	76,210	1,918	25.17
Maine	3	7,382	3,782	207	54.66
Maryland	1	2,345	2,345	39	16.44
Michigan	17	244,925	244,925	3,206	13.09
Minnesota	5	19,158	13,363	230	17.20
Montana	3	2,202	1,105	51	46.46
New Jersey	4	28,706	29,425	686	23.31
New York	6	35,764	21,844	377	17.27
Ohio	7	7,697	4,444	99	22.35
Pennsylvania	8	26,927	26,927	488	18.11
South Carolina	1	18,297	18,297	W	W
Vermont	1	100	100	W	W
Washington	6	12,731	12,731	98	7.70
Wisconsin	4	11,330	11,330	502	44.31
Other States [1]	7	64,246	64,246	1,560	24.28
Total	109	771,716	745,636	12,294	16.49

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes California, Iowa, Massachusetts, North Dakota, and States indicated by symbol W.

Table 4.—Relative size of peat operations in the United States

Size	1974 Active plants: Number	1974 Active plants: Percent of total	1974 Production: Short tons	1974 Production: Percent of total	1975 Active plants: Number	1975 Active plants: Percent of total	1975 Production: Short tons	1975 Production: Percent of total
Under 500 tons	21	20.6	4,384	0.6	22	20.2	3,597	0.5
500 to 999 tons	9	8.8	6,035	.8	11	10.0	7,629	1.0
1,000 to 4,999 tons	40	39.2	94,899	13.0	44	40.4	111,507	14.5
5,000 to 14,999 tons	22	21.6	201,206	27.5	18	16.5	153,558	19.9
15,000 to 24,999 tons	5	4.9	89,278	12.2	9	8.3	176,825	22.9
Over 25,000 tons	5	4.9	335,202	45.9	5	4.6	318,600	41.2
Total	102	100.0	731,004	100.0	109	100.0	771,716	100.0

CONSUMPTION AND USES

The amount of peat available for consumption remained at practically the same level in 1975, increasing less than 1%. This was principally due to the fact that imports decreased 11% from those of 1974.

Peat was used for a variety of purposes, but 81% of the total commercial sales reported by producers was used for general soil improvement. Among the principal markets for this peat were nurseries and greenhouses, which used peat as a mulch and as a medium for growing plants and shrubs; landscape gardeners and contractors, who used peat for building and maintaining lawns, golf-course greens, and for transplanting trees and shrubs; and garden, hardware, and variety stores, which sold peat to homeowners for mulching and improving lawn and garden soils. The remaining peat was sold principally for use in potting soils, a market that has grown greatly in the past few years along with the household plant industry.

Peat was also used for packing flowers and shrubs, and in mushroom beds. Small quantities were used for earthworm culture, seed inoculant, and in mixed fertilizers.

About 55% of the peat sold commercially by producers was packaged, and packaged peat accounted for 68% of the total value of sales. Package sizes varied greatly, but most producers used 40-pound bags, a change from the 50-pound bags previously used. The use of smaller bags for packaging both peat and potting soils has grown rapidly in the past several years and 5-, 10-, and 20-pound bags of each are commonly being produced for household use. About 69% of the packaged peat sold in 1975 was of the reed-sedge type, 17% was moss, and the remainder was humus.

States leading in sales of packaged peat were Michigan, Illinois, and Indiana. Together, these States reported 79% of total sales of packaged peat. Michigan, the largest producer, had 49% of the total sales.

Of the bulk peat, 64% was reportedly sold for general soil improvement. The remainder of the bulk peat was sold mainly for use in potting soils, for packing flowers and shrubs, and in mixed fertilizers.

Table 5.—Commercial sales of peat in the United States in 1975, by kind and use

Use	Moss		Reed-sedge		Humus	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Bulk:						
Soil improvement	98,751	$1,167	69,318	$811	44,213	$501
Other uses	58,335	605	20,352	323	40,926	575
Total	157,086	1,772	89,670	1,134	85,139	1,076
Packaged:						
Soil improvement	47,383	1,400	284,935	4,180	56,185	1,232
Other uses	23,156	1,345	864	38	1,218	116
Total	70,539	[1]2,746	285,799	4,218	57,403	1,348
Total:						
Soil improvement	146,134	[1]2,568	354,253	4,991	100,398	1,733
Other uses	81,491	1,950	21,216	361	42,144	691
Grand total	227,625	4,518	375,469	5,352	142,542	2,424

[1] Data may not add to totals shown because of independent rounding.

Table 6.—Commercial sales of peat in the United States in 1975, by use

Use	In bulk		In packages		Total [1]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Soil improvement	212,282	$2,479	388,503	$6,812	600,785	$9,292
Seed inoculant	75	1	54	4	129	5
Packing flowers, shrubs, etc	14,490	142	20,167	1,298	34,657	1,440
Potting soils	83,337	1,178	4,425	129	87,762	1,308
Mushroom beds	4,315	77	--	--	4,315	77
Earthworm culture	3,872	42	45	(2)	3,917	43
Mixed fertilizers	12,750	50	--	--	12,750	50
Other	774	12	547	67	1,321	80
Total [1]	331,895	3,982	413,741	8,312	745,636	12,294

[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.

PRICES AND SPECIFICATIONS

Prices of peat at individual operations varied greatly in 1975, with the price depending mainly upon the kind of peat sold, the amount of processing, and whether the peat was sold in bulk or packaged form.

The overall average value per ton, f.o.b. plant, for all peat sold in 1975 was $16.49, up from $15.56 in 1974. Most of the increase was attributed to higher average receipts for peat sold in 9 States, with significant increases occurring in Indiana, California, New York, and Ohio.

The average price of bulk peat was $12.00 per ton, an increase of $1.22. Packaged prices increased an average of $0.40 per ton to $20.09. The average price of bulk peat in the United States was influenced mainly by higher overall prices and increased quantities of bulk sales by producers in Illinois, Ohio, and Minnesota. The increase in the unit value of packaged peat was attributed to higher receipts for packaged peat sold by Indiana, California, New York, and Florida producers.

In a few instances, when producers did not report the value of peat sold, the sales value was calculated based upon the average value of a similar type peat sold within the State.

Imported peat had a total value of $23.9 million. This value was 6% greater than in 1974, principally because the average value per ton increased from $69.16 to $82.17.

Although the average value of imported peat was four times that of domestically produced packaged peat, these values are not comparable because of different marketing levels. Also, imported peat has different physical properties than most domestic peat, and it usually is sold on a volume basis rather than by weight. Each 100 pounds of a typical air-dried imported peat will measure approximately 12 bushels, whereas the same weight of a typical domestic peat will measure only 3 or 4 bushels. A few domestic operations, in the northern latitudes, produced peat with properties similar to those of the imported kind.

FOREIGN TRADE

The quantity of peat imported into the United States in 1975 totaled 290,000 short tons. This tonnage was 11% less than that imported in 1974, and the first quantitative drop in imports since 1970. Canada provided the bulk of the peat imports, supplying 98% of the total. Virtually all of the remaining foreign peat was supplied by Europe.

European shipments decreased 48%, owing principally to a substantial drop in shipments from West Germany. West Germany supplied 97% of the peat imported from Europe.

Imported peat was classified according to use, either as poultry- and stable-grade or as fertilizer-grade. Except for a duty of $0.50 per long ton levied on poultry- and stable-grade peat from countries with centrally controlled economies, there was no tariff on peat.

Foreign peat entered the United States through 29 customs districts in 1975, but 89% of the total was shipped through the customs districts of Buffalo and Ogdensburg, N.Y., Detroit, Mich., Pembina, N. Dak., St. Albans, Vt., Portland, Maine, and Seattle, Wash. The largest quantity, 86,000 tons, was shipped through the Ogdensburg district.

Table 7.—U.S. imports for consumption of peat moss, by grade and country

Country	Poultry and stable-grade Quantity (short tons)	Poultry and stable-grade Value (thousands)	Fertilizer-grade Quantity (short tons)	Fertilizer-grade Value (thousands)	Total Quantity (short tons)	Total Value (thousands)
1974						
Canada	2,667	$226	309,221	$21,429	311,888	$21,655
Finland	--	--	14	8	14	8
Germany, West	580	38	12,816	822	13,396	860
Honduras	--	--	15	(1)	15	(1)
India	2	1	--	--	2	1
Ireland	18	1	--	--	18	1
Japan	--	--	752	34	752	34
Netherlands	--	--	1	1	1	1
Poland	--	--	157	16	157	16
United Kingdom	--	--	287	6	287	6
Total	3,267	266	323,263	22,316	326,530	22,582
1975						
Canada	6,243	455	276,947	22,858	283,190	23,313
Denmark	7	(1)	--	--	7	(1)
Germany, West	337	26	6,567	512	6,904	538
Guatemala	1	3	--	--	1	3
Ireland	10	(1)	--	--	10	(1)
Mexico	18	3	--	--	18	3
Netherlands	10	1	--	--	10	1
United Kingdom	--	--	218	1	218	1
Total	6,626	488	283,732	23,371	290,358	23,859

[1] Less than ½ unit.

Table 8.—U.S. imports for consumption of peat moss in 1975, by grade and customs district

Customs district	Poultry and stable-grade Quantity (short tons)	Poultry and stable-grade Value (thousands)	Fertilizer-grade Quantity (short tons)	Fertilizer-grade Value (thousands)	Total Quantity (short tons)	Total Value (thousands)
Baltimore, Md	--	--	414	$36	414	$36
Boston, Mass	--	--	75	6	75	6
Buffalo, N.Y	--	--	17,357	1,296	17,357	1,296
Charleston, N.C	--	--	15	2	15	2
Chicago, Ill	7	(1)	--	--	7	(1)
Cleveland, Ohio	10	(1)	--	--	10	(1)
Detroit, Mich	1,987	$124	37,541	3,132	39,528	3,256
Duluth, Minn	17	1	11,035	1,177	11,052	1,178
Great Falls, Mont	--	--	12,693	977	12,693	977
Houston, Tex	--	--	336	28	336	28
Laredo, Tex	18	3	--	--	18	3
Los Angeles, Calif	--	--	684	63	684	63
Miami, Fla	52	4	294	26	346	30
Mobile, Ala	--	--	307	21	307	21
New Orleans, La	30	6	1,170	81	1,200	87
New York, N.Y	56	3	337	26	393	29
Norfolk, Va	10	1	505	36	515	37
Ogdensburg, N.Y	--	--	86,106	6,496	86,106	6,496
Pembina, N. Dak	979	106	16,790	1,549	17,769	1,655
Philadelphia, Pa	--	--	303	25	303	25
Port Arthur, Tex	--	--	47	5	47	5
Portland, Maine	3,244	222	25,338	2,046	28,582	2,268
Portland, Oreg	26	1	--	--	26	1
St. Albans, Vt	16	2	27,962	2,126	27,978	2,128
San Francisco, Calif	68	8	18	1	86	9
San Juan, P.R	--	--	662	60	662	60
Savannah, Ga	--	--	251	17	251	17
Seattle, Wash	--	--	42,240	4,051	42,240	4,051
Tampa, Fla	106	7	1,252	88	1,358	95
Total	6,626	488	283,732	23,371	290,358	23,859

[1] Less than ½ unit.

Table 9.—Peat moss imported for consumption from Canada and West Germany in 1975, by grade and customs district

Customs district	Canada				West Germany			
	Poultry and stable-grade		Fertilizer-grade		Poultry and stable-grade		Fertilizer-grade	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Baltimore, Md	--	--	--	--	--	--	414	$36
Boston, Mass	--	--	25	$2	--	--	50	4
Buffalo, N.Y	--	--	17,357	1,296	--	--	--	--
Charleston, N.C	--	--	--	--	--	--	15	2
Detroit, Mich	1,987	$124	37,541	3,132	--	--	--	--
Duluth, Minn	17	1	11,035	1,177	--	--	--	--
Great Falls, Mont	--	--	12,693	977	--	--	--	--
Houston, Tex	--	--	--	--	--	--	336	28
Los Angeles, Calif	--	--	--	--	--	--	684	63
Miami, Fla	--	--	--	--	52	$4	294	26
Mobile, Ala	--	--	--	--	--	--	307	21
New Orleans, La	--	--	--	--	29	3	1,170	81
New York, N.Y	--	--	--	--	56	3	337	26
Norfolk, Va	--	--	--	--	--	--	505	36
Ogdensburg, N.Y	--	--	85,888	6,495	--	--	--	--
Pembina, N.Dak	979	106	16,790	1,549	--	--	--	--
Philadelphia, Pa	--	--	31	2	--	--	272	23
Port Arthur, Tex	--	--	47	5	--	--	--	--
Portland, Maine	3,244	222	25,338	2,046	--	--	--	--
Portland, Oreg	--	--	--	--	26	1	--	--
St. Albans, Vt	16	2	27,962	2,126	--	--	--	--
San Francisco, Calif	--	--	--	--	68	8	18	1
San Juan, P.R	--	--	--	--	--	--	662	60
Savannah, Ga	--	--	--	--	--	--	251	17
Seattle, Wash	--	--	42,240	4,051	--	--	--	--
Tampa, Fla	--	--	--	--	106	7	1,252	88
Total	6,243	455	276,947	22,858	337	26	6,567	512

WORLD REVIEW

World production of peat in 1975 was estimated at 223 million tons, about 1% more than the output reported for 1974.

The U.S.S.R. was by far the largest peat producer, with an estimated 95% of the world production. According to published U.S.S.R. figures, 145 million tons of peat was produced by State enterprises for agricultural use, and an estimated 66 million tons was used for fuel. Agricultural peat was used for general soil improvement and the manufacture of fertilizers, and fuel peat was used for generating electric power and for industrial and domestic heating.

Ireland ranked second in peat production, with an estimated 7.7 million tons, an increase of 60% from 1974 production. Virtually all of Ireland's production was fuel peat used for generating electric power and for heating households. A small amount of agricultural peat was produced, principally for export.

West Germany, the third-ranking peat producer, with 1.8 million tons, provided about 1% of the world output. Most of the West German production was agricultural peat; only 14% was consumed as a fuel.

Other producers, ranking in output in the order named, were the United States, the Netherlands, Canada, and Finland. However, the combined output of these countries was less than 1% of the total. Although fourth in world production, the United States output was less than 0.5% of the world total.

Since the oil embargo of 1973 and the subsequent increase in fuel oil costs, peat has been seriously studied as a competitive fuel source in some European countries.

Ireland, which is second only to the U.S.S.R. in using fuel peat for generating electricity, is planning to expand its generating capacity about 37% to 587 megawatts by 1980 and develop an additional 40,000 acres of peatlands for fuel peat production. In 1974, Ireland was generating approximately 24% of its electricity using peat as fuel.[2]

[2] O'Donnel, S. Ireland Turns to Peat. New Scientist, v. 63, July 1974, pp. 18–19.

In Finland, an attempt to develop an internal energy source has led to the early stages of utilizing peat as a fuel. In 1974, 436 Mw of power was produced, using peat-fired mobile power generators. Finland has developed a dual power system, using peat to provide energy for both electrical generation and municipal heating. This system allows energy-conversion efficiencies of up to 85%. Finland's peat should provide 0.5% of that Nation's energy requirements by 1980.[3]

Table 10.—Peat: World production, by country
(Thousand short tons)

Country [1]	1973	1974	1975 [p]
Argentina, agricultural use	11	10	[e] 10
Australia	6	1	[e] 4
Canada, agricultural use	359	407	383
Denmark, fuel	[2] 43	[2] 35	[e] 70
Finland:			
Agricultural use [e]	125	[r] 100	130
Fuel	[e] 190	128	220
France, agricultural use	169	[r] [e] 175	[e] 175
Germany, West:			
Agricultural use	1,937	2,062	[e] 1,586
Fuel	308	206	250
Hungary, agricultural use [e]	72	72	72
Ireland:			
Agricultural use	85	[r] [e] 82	[e] 74
Fuel	4,245	[r] [e] 4,694	[e] 7,579
Israel, agricultural use [e]	22	22	22
Japan [e]	80	80	80
Korea, Republic of, agricultural use	4	[e] 4	[e] 4
Netherlands [e]	440	440	440
Norway:			
Agricultural use [e]	[r] 45	[r] 62	66
Fuel [e]	[r] 1	[r] 1	1
Poland:			
Agricultural use [e]	40	40	40
Fuel	5	5	5
Spain	17	[e] 17	[e] 17
Sweden:			
Agricultural use	75	81	[e] 83
Fuel	31	40	[e] 44
U.S.S.R.:			
Agricultural use [e]	146,700	145,100	145,100
Fuel [e]	64,500	66,100	66,100
United States, agricultural use	635	731	772
Total	[r] 220,145	220,695	223,327
Fuel peat included in total	[r] 69,323	71,209	74,269

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, Austria, Iceland, and Italy produce a negligible quantity of fuel peat. No data are available for East Germany, a major producer.
[2] Sales.

TECHNOLOGY

The Fuel and Lubricant Research Laboratory of the Technical Research Centre of Finland has been investigating the production of coke and active carbon from peat in the laboratory and in a pilot plant.

In 1975, the State Fuel Centre of Finland began construction of a peat coke plant having an annual capacity of 30,000 tons. The peat coke produced at this plant will be used with metallurgical coal coke for the production of ferric chrome.

Research has found that the production of good peat coke is dependent on the type of peat used and the method of processing. A dense peat, usually having humic characteristics and a low-inorganic content, produces the most economic coke. Mechanical molding of the peat was found to be important since it critically affects the shrinkage. The molding is usually accomplished by using sod- or briquet-production techniques. Molding also reduces the number of pores larger than 100 nanometers produced by air-drying and, along with the adding of alkalic chemicals, can intensify the strength of the air-dried peat, which results in a stronger coke.

[3] McLain, L. Finn's Power Policy Offers Added Spark to British Industry. Eng., v. 240, Mar. 13, 1975, p. 26.

Molded peat shrinks approximately 80% when it is air-dried. The shrinkage continues during carbonization, peaking when the organic matter decomposes and gaseous substances are formed. This process begins at about 250°–300° C, is most intensive at about 350°–400° C, but drops off sharply at higher temperatures. A total of 40%–50% additional shrinkage occurs during carbonization.

Peat coke differs from coal coke in that it is about twice as reactive, is more porous, and has a lower sulfur content. It also has a higher electrical resistance owing to its varied carbon structure. For this reason, peat coke can be used for smelting silicic and chromic alloys in electric furnaces. Its high reactivity also allows it to be mixed with coal coke to increase output. The use of peat coke is limited by its poor strength properties and higher price, although current energy costs have made it more competitive.[4]

The State Fuel Centre is also utilizing peat to combat oil pollution. Finland has had problems with accidental oil spills amounting to hundreds of tons of crude and heavy fuel oil. During the winter, there is no way of cleaning up these spills other than burning; however, this is difficult since the spilled oils become emulsified with the cold water by wave agitation and develop a high water content. Also, after floating for as long as 2 days, the oil layers are sufficiently cooled by the underlying water to make the oil difficult to ignite. Peat, saturated with light oil or petroleum, can be spread upon the oil slick and burned in order to provide enough heat to ignite the oil. The peat ash also continues to absorb the oil, allowing it to keep burning.

Since 1973, a dried, compacted peat has been packaged in 6-cubic-foot bags at the State briquet factory in Kihnio, Finland. These bags are being stored for emergency use along waterways, at ports where oil is being handled, and on land to combat oil pollution.[5]

In Finland, 436 Mw of electricity were produced in 1974, using peat-fueled mobile power generators connected to gas turbines manufactured in Italy.[6] Scotland is also investigating the use of mobile, gas-turbine-based units in order to utilize Scottish peat resources for generating electricity. These gas turbines burn dried, pulverized peat in a near-stoichiometric input of air, to insure a reasonably complete combustion. The hot products of combustion (POC) are passed through a chamber of air-dried peat to further dry it. The POC, in turn, creates steam from the moisture it picks up, thereby cooling itself so that the steam-POC mixture is at a suitable temperature for entering the turbine. The peat is transferred from chamber to chamber in the system by the use of fluidic switches, which are not susceptible to corrosion, while the blades of the turbine itself are sweat-cooled to prevent ash deposits from forming.[7]

In the United States, the Hussong-Walker-Davis Co. of Cornwells Heights, Pa., has experimented with peat as a medium for treating dye-house effluent. Tests performed using the Hussong-Couplan process, in which peat is used as the filtering agent, resulted in the removal of 99.6% of the color, 100% of the turbidity, 98.7% of the chemical oxygen demand, 95% of the biological oxygen demand, 87.8% of the total oxygen demand, 97.7% of the phosphates, and 98.1% of the suspended solids. The peat filters reduced cyanide 100% and heavy-metal pollutants as follows: Hexavalent chromium, and trivalent chromium, copper, nickel, and mercury, 99.9%; cadmium and lead, 99.6%; iron, 99.2%; zinc, 98.9%; and antimony, 98.3%.

The Hussong-Couplan system is based on passing effluent through the scrubbing action of a moving mat of peat. Since most of the pollutants are in solution, they are either chemically adsorbed by the peat or form an insoluble complex salt through ionic bonding. The process consists of preparing peat mats by producing a water-peat slurry in a weight ratio of 100:1. The slurry is deposited on a moving, perforated belt, which allows the excess water to drain off, leaving a uniform mat of peat. The mat moves under discharge pipes that spray the effluent through the peat. The effluent is passed through the peat twice, with the first-pass effluent being collected in basins and stored in tanks between passes. After the second pass, the cleaned liquid is either recycled or discharged.

[4] Ekman, E. Peat as Raw Material for Metallurgical Coke. Internat. Peat Soc. Bull. 7, 1975, pp. 39–49.
[5] Ekman, E. Finnish Peatlands and Their Utilization. Finnish Peatland Soc., Helsinki, 1973, p. 37.
[6] Page 26 of work cited in footnote 3.
[7] Macnair, E. J. Peat Power in Scotland. Energy World, May 1974, pp. 6–7.

The resulting spent peat can be disposed of in environmentally sound ways. It can be buried in sanitary landfills safely, since the metal pollutants are in an insoluble form. Or it can be dried and burned and the heavy-metal pollutants recovered. The used peat is the only by-product of the system.

The Hussong-Couplan system comes in modular, self-contained units 8 by 16 by 9 feet high, and has a capacity of handling 110,000 gallons of effluent per unit in a 24-hour period. The system is capable of meeting the requirements of the U.S. Environmental Protection Agency.

Since the supply of clean water is expected to decrease in the future, recycling water for industrial purposes will become more important in the future.[8]

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[8] Leslie, M. E. Peat: New Medium for Treating Dye House Effluent. Amer. Dyestuff Reporter, v. 63, August 1974, pp. 16–18.

Perlite

By Arthur C. Meisinger [1]

Although the quantity of crude perlite mined in the United States in 1975 was 706,000 tons, the second highest tonnage on record, the tonnage of crude ore sold and used by producers was nearly 8% less than the record high quantity (555,000) established in 1974. Value of crude perlite sold or used, however, was a record $7.28 million, or $257,000 more than the previous record value set in 1974. Deposits in New Mexico supplied 85% of the total crude perlite mined in 1975.

Value of expanded perlite sold or used in 1975 was $34.3 million, a new record that exceeded the old record high value of $30.8 million (revised) in 1974 by $3.5 million. Illinois continued to be the leading State in the production of expanded perlite.

The newly reopened Socorro, N. Mex. mining operation of Grefco, Inc., made its first shipment of crude ore in December, and the new processing plant is expected to be onstream in 1976.

DOMESTIC PRODUCTION

Crude perlite was produced by 11 companies at 12 mines in 6 States. The quantity of crude ore mined was 706,000 tons, the second highest tonnage on record and 4% greater than the quantity (676,000 tons) mined in 1974. New Mexico continued as the primary producing State with 85% of the crude perlite mined in 1975, followed by Arizona, California, Colorado, Nevada, and Idaho in descending order of production.

The quantity of crude perlite sold or used by domestic producers was 512,000 tons, 8% less than the record high 555,000 tons sold or used in 1974. The value of crude perlite sold or used, however, was a new record of $7.28 million and exceeded the old record high value of $7.02 million in 1974 by $257,000.

Expanded perlite was produced at 69 plants in 29 States in 1975 compared with 76 plants in 30 States in 1974. The quantity of expanded perlite produced declined for the third straight year and was 22,000 tons lower than the 1974 figure. The quantity of expanded perlite sold or used in 1975 by producers was 394,000 tons, the lowest quantity since 1971. Value of expanded perlite sold or used, however, set an alltime high of nearly $34.3 million, compared with the 1974 record value of $30.8 million (revised).

The leading States in descending order of expanded perlite production in 1975 were Illinois, Texas, Mississippi, Kentucky, Pennsylvania, New Jersey, Colorado, Caiifornia, Florida, and Indiana.

The new Socorro, N. Mex. perlite mining operations of Grefco, Inc., Los Angeles, Calif., went onstream at yearend. Processing of the crude ore is expected to begin in 1976.

Producers of crude perlite during the year were Filters International, Inc., Harborlite Corp., and Guzman Construction Co. with operations near Superior, Ariz.; American Perlite Corp., with deposits in Inyo County, Calif.; Persolite Products, Inc., Rosita, Colo.; Oneida Perlite Corp., near Malad City, Idaho; Delamar-Mackie Perlite, Caliente, Nev.; United States Gypsum Co., with operations at Lovelock, Nev., and Grants, N. Mex.; and Silbrico Corp., Johns-Manville Sales Corp., and Grefco, Inc., with operations in Taos County, N Mex.

[1] Industry economist, Division of Nonmetallic Minerals.

Table 1.—Crude and expanded perlite produced and sold or used by producers in the United States

(Thousand short tons and thousand dollars)

Year	Crude perlite: Quantity mined	Sold: Quantity	Sold: Value	Used at own plant to make expanded material: Quantity	Used at own plant to make expanded material: Value	Total quantity sold or used	Expanded perlite: Quantity produced	Expanded perlite: Sold or used: Quantity	Expanded perlite: Sold or used: Value
1971	495	175	2,062	257	2,879	432	389	385	23,156
1972	649	224	2,540	321	3,691	545	427	421	28,397
1973	759	238	2,771	306	2,819	544	424	418	28,005
1974	676	275	3,544	280	3,480	555	423	419	r 30,808
1975	706	239	3,407	273	3,874	512	401	394	34,258

r Revised.

Table 2.—Expanded perlite produced and sold or used by producers in the United States

State	1974: Quantity produced (short tons)	1974: Sold or used: Quantity (short tons)	1974: Sold or used: Value (thousands)	1974: Sold or used: Average value per ton	1975: Quantity produced (short tons)	1975: Sold or used: Quantity (short tons)	1975: Sold or used: Value (thousands)	1975: Sold or used: Average value per ton
California	23,001	21,137	$1,978	$93.60	25,009	24,300	$2,695	$110.91
Florida	24,006	24,038	1,403	58.37	21,286	21,344	1,431	67.06
Indiana	16,212	15,753	1,070	67.92	15,499	15,144	1,122	74.08
Kansas	580	580	101	174.14	800	831	123	147.96
Missouri	6,000	5,906	475	80.43	5,400	5,392	658	122.03
New York	4,988	4,988	516	103.45	5,371	5,229	664	126.98
Ohio	12,138	12,138	825	67.97	11,997	11,941	996	83.39
Pennsylvania	38,204	39,232	2,684	68.41	33,693	33,343	2,619	78.55
Texas	22,286	22,141	r 1,636	r 73.91	39,777	38,577	2,580	66.87
Other States [1]	275,450	273,583	20,120	r 73.54	242,442	237,870	21,370	89.84
Total	422,865	419,496	r 30,808	r 73.44	401,274	393,971	34,258	86.96

r Revised.

[1] Includes Colorado, Georgia, Idaho, Illinois, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota (1974), Mississippi, Nebraska, Nevada, New Hampshire, New Jersey, Oregon, Tennessee, Utah, and Wisconsin.

CONSUMPTION AND USES

Domestic consumption of expanded perlite was 394,000 tons, or 6% less than that in 1974. A percent distribution by end use is shown in table 3. Three major end-use categories (filter aids, horticultural aggregates, and formed products) showed significant gains in 1975, but four end-use categories (plaster aggregates, low-temperature insulation, masonry and cavity fill insulation, and other uses) declined from 1974 in percent of total consumption. Use of perlite in concrete aggregates (8%) and in fillers (1%) in 1975 was unchanged from that in 1974. Other uses reported in table 3 include primarily insulation board and a variety of uses such as paint textures, foundry castables and bonding agents, polishing compounds, and fines for various industrial uses.

Table 3.—End use of expanded perlite

(Percent)

Use	1974	1975
Filter aids	17	21
Plaster aggregate	9	8
Concrete aggregate	8	8
Horticultural aggregate	6	8
Low-temperature insulation	5	1
Masonry and cavity fill insulation	4	3
Fillers	1	1
Formed products	8	11
Other [1]	42	39

[1] Includes insulation board.

PRICES

Producers sold crushed, cleaned, and sized crude perlite to expanding plants at an average price of $14.26 per ton, an increase of $1.37 per ton over that in 1974. Crude perlite used by producers in their own expanding plants was valued at $14.19

per ton, an increase of $1.76 per ton compared with that of 1974. The weighted average price of both categories was $14.22 per ton compared with $12.66 per ton in 1974.

Expanded perlite sold or used, according to expanders, was valued at $86.96 per ton compared with $73.44 per ton (revised) in 1974. Average values for expanded perlite by States ranged from $36 to $186 per ton, compared with the 1974 range of $28 to $174 per ton.

WORLD REVIEW

Greece.—Excluding the U.S.S.R., Greece is the leading producer of crude perlite in Europe. Although data on perlite production were not available for 1975, the country produced 231,400 tons of crude perlite in 1974 compared with 273,300 tons in 1973, and processed 125,900 tons for export compared with 138,600 tons in 1973. Greek producers exported 140,250 tons of perlite in 1974, of which about 10% was unprocessed ore.

Mexico.—The quantity of crude perlite produced increased substantially (57%), from 13,400 tons in 1974 to 21,000 tons. Four companies in Mexico expanded perlite at two plants near Mexico City and one plant each in the States of Monterey and Sonora.

Philippines.—Output of crude perlite from the Trinity Lodge Mining Corp. deposit was 733 tons compared with 1,248 tons in 1974. Perlite Minerals and Industrial Corp. at Ermita, Manila, was reported to be studying the feasibility of a joint venture for processing, expanding and marketing perlite for domestic construction products, such as ceiling tiles and insulation board.

Turkey.—Data on mine production of perlite were not available for 1975, but approximately 22,000 tons was mined in 1974, and an estimated 16,500 tons was reported to have been exported by Turkey. About 90% of the annual crude perlite output comes from mining operations in the West Anatolian region of the country near the Aegean Sea.

United Kingdom.—Tiling Construction Services Ltd. (Tilcon) announced in 1975 the opening of the company's new perlite expanding plant at Kirkby, near Liverpool, England.[2] Tilcon also operated an expanding plant in Buxton, Derbyshire, England, for producing a lightweight perlite mortar aggregate that is marketed under the trade name, Limelite. The Kirkby plant is designed to produce filtration-grade perlite and various industrial perlite products for market areas in Scotland, the north of England, and other areas of the United Kingdom.

[2] Quarry Management (London). New Perlite plant at Kirkby. V. 2, No. 2, February 1975, p. 51.

Crude Petroleum and Petroleum Products

By William B. Harper,[1] Bernadette C. Michalski,[2] and Michelle R. Parker [3]

CONTENTS

Petroleum demand[4] in 1975 was moderately below 1974 levels as increases in motor gasoline consumption failed to offset marked declines for other major products. Reduced demand for distillate fuel oil and residual fuel oil, for example, resulted in part from a mild winter and in part from the economic recession. The net result was that overall domestic demand declined in 1975 to about 16.3 million barrels per day (bpd) from 16.7 million bpd in 1974, or about 2%. Production of crude oil, lease condensate, and natural gas liquids also declined, however, making it necessary to increase crude imports to augment new supply to meet demand.

New supply consists of domestic production of crude oil, lease condensate, and natural gas plant liquids, plus imports. In 1975, imports accounted for 37% of total new supply. In 1972, a year before the

[1] Mineral industry specialist (petroleum), Division of Petroleum and Natural Gas.
[2] Mineral specialist, Division of Petroleum and Natural Gas.
[3] Statistical assistant, Division of Fuels Data.
[4] Certain terms as used in this chapter are more or less unique to the petroleum industry. Principal terms and their meanings are—

Total demand.—A derived figure representing total new supply plus decreases or minus increases in reported stocks. Because there are substantial consumers' stocks that are not reported to the Bureau of Mines, this figure varies considerably from consumption as reported by the Federal Highway Administration of the Department of Transportation.

Domestic demand.—Total demand less exports.

New supply of all oils.—The sum of crude oil production plus production of natural gas liquids, plus benzol (coke oven) used for motor fuel, hydrogen, and other hydrocarbons, plus imports of crude oil and other petroleum products.

Transfers.—Crude oil conveyed to fuel-oil stocks without processing, or reclassification of products from one product category to another.

All oils.—Crude petroleum, natural gas liquids, and their derivatives.

Exports.—Includes shipments to U.S. territories, possessions, and free trade zones.

Imports.—Includes receipts from U.S. territories, possessions, and free trade zones.

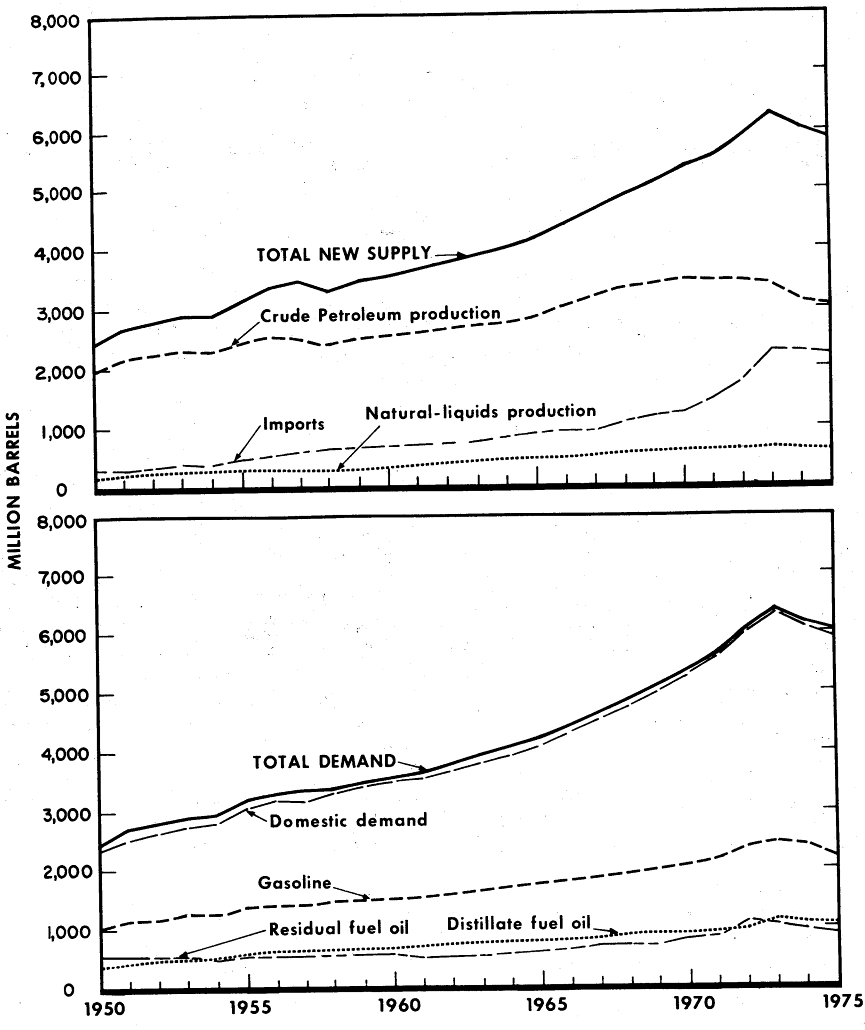


Figure 1.—Supply and demand of all oils in the United States.

Arab oil embargo, imports accounted for nearly 30%. Crude oil imports averaged 4.1 million bpd in 1975, an increase of 18% over the 1974 level. Other imports, such as refined products, unfinished oils, and plant condensate, declined 27% as domestic refineries ran more crude oil to produce larger volumes of refined products.

Refineries in 1975 operated at 81.7% of operable capacity. This ratio is obtained by relating crude runs to stills in 1975, averaging 12,442,000 barrels per day (bpd), to the total operable capacity at the end of 1975 of 15,236,000 bpd: if the operable but shutdown capacity is omitted from the total, the operating ratio increased to 83.7% in 1975.

Four lease sales were conducted in 1975 by the Bureau of Land Management, U.S. Department of the Interior. These sales, held in February, May, July, and December, involved 1,679,877 acres, and the bonuses aggregated over $1 billion, as shown in the following tabulation:

Offshore location	Date	Offered		Leased		Total high-bid accepted
		Tracts	Acreage	Tracts	Acreage	
Texas	Feb. 4	515	2,870,344	113	626,585	$274,690,955
Louisiana–Texas	May 28	283	1,346,432	86	406,942	232,916,050
Do	July 29	345	1,772,958	66	336,301	163,214,006
Southern California	Dec. 11	231	1,258,189	56	310,049	417,312,141
Total		1,374	7,247,923	321	1,679,877	1,088,133,152

Drilling activity accelerated in 1975. The weekly activity of 1,659 rotary rigs was the highest in 12 years, according to the Hughes Tool Co. The American Petroleum Institute (API) reported there were 16,408 oil wells completed in 1975, an increase of 28%. There were 7,580 gas wells drilled in 1975, 5% more than in 1974.

A very large segment of drilling activity related to "infill" development well drilling; that is, drilling in known fields. Much of this activity was attributed to the "two tier" pricing of crude oil. On one tier was "old" oil priced at $5.25 per barrel and on the other tier was "new" oil priced in December 1975 at $12.95 per barrel. In 1975, there were three classes of uncontrolled oil: New, released and stripper. Subsequent legislation in the Energy Policy and Conservation Act eliminated the "released" category, but new oil and stripper oil remained in the FEA classification.

According to API estimates, proved reserves of crude oil declined for the fifth consecutive year as production withdrawals continued to exceed additions to reserves.

Work on the Trans-Alaska Pipeline was progressing, and the target date for startup for moving crude to Valdez, Alaska was mid-1977. Initial throughput was expected to average about 600,000 bpd in 1977.

Reserves of 32.7 billion barrels at yearend 1975 represented a reserve-to-production ratio for crude oil of 11:1 (based on 1975 production).

Refinery operable capacity at yearend 1975 in the United States and Puerto Rico amounted to 15.5 million bpd, up nearly 2% from yearend 1974. Following the discontinuance of import quotas on crude oil and petroleum products, many refiners announced expansion plans that could increase throughput capacity to 16.1 million bpd. Most of the proposed new capacity is scheduled to run imported crude oil.

Table 1.—Salient statistics of crude petroleum, refined products, and natural gas liquids in the United States

(Thousand 42-gallon barrels unless otherwise indicated)

	1971	1972	1973	1974	1975 [p]
Crude petroleum:					
Domestic production (including lease condensate)	3,453,914	3,455,368	3,360,903	3,202,585	3,056,779
World production	17,662,793	18,600,745	20,367,981	20,537,727	19,475,700
U.S. proportion ---percent--	20	19	17	16	16
Exports [1]	503	187	697	1,074	2,146
Imports [2]	613,417	811,135	1,183,996	1,269,155	1,498,181
Stocks, end of year	259,648	246,395	242,478	265,020	271,354
Runs to stills	4,087,809	4,280,863	4,537,254	4,428,726	4,541,426
Value of domestic production at wells:					
Total ---thousands--	$11,692,998	$11,706,510	$13,057,905	$21,580,549	$23,116,059
Average per barrel	$3.39	$3.39	$3.89	$6.74	$7.56
Total producing oil wells, Dec. 31	517,318	508,443	497,378	497,631	500,333
Total oil wells completed during year (successful wells)	11,858	11,306	9,902	12,784	16,408
Refined products:					
Exports [1]	81,342	81,202	83,716	79,417	74,282
Imports (including unfinished oils and plant condensate) [3]	819,463	924,179	1,099,497	961,792	700,815
Stocks, end of year [4]	784,299	712,584	765,829	808,626	861,601
Completed refineries, end of year	[r] 282	277	284	290	287
Daily crude-oil capacity	13,437	13,775	14,489	15,169	15,428
Natural gas liquids:					
Production	617,815	638,216	634,423	616,098	595,958
Stocks, end of year	88,421	79,238	94,106	108,377	118,214
All oils:					
Total disposition of primary supply	5,638,853	6,076,346	6,406,613	6,163,519	6,027,503
Exports	81,845	81,389	84,413	80,491	76,423
Total domestic demand for products (including crude-oil losses)	5,557,008	5,994,957	6,322,200	6,083,028	5,951,075

[p] Preliminary (except for crude production and value). [r] Revised.
[1] U.S. Department of Commerce data.
[2] Reported to the Bureau of Mines.
[3] U.S. Department of Commerce data, Oil Import Administration, and Federal Energy Administration, except for unfinished oils and plant condensate which are Bureau of Mines.
[4] Stocks of refined products also include stocks of unfinished oils, natural gasoline, plant condensate, and isopentane.

CRUDE PETROLEUM

PRODUCTION

Production of crude oil (including lease condensate) in 1975 continued the downtrend that began after 1970. Total production in 1975 was about 3.1 billion barrels, nearly 5% below that of 1974. There were declines in 22 of the 31 oil-producing States. The sharpest decline occurred in the gulf coast region of Louisiana, which had a drop of 80 million barrels, or 11.5%. In Texas, gains in West Texas failed to offset declines in other parts of the State, so there was a net decline in 1975 of 40.2 million barrels, or 3.2%.

The overall decline continued in 1975 but at a more moderate rate, particularly in Texas. On the plus side, production has increased in Alabama, Colorado, Florida, Michigan, Ohio, Utah, and in the San Joaquin Basin of California over each of the past 5 years and these six States and one area produced 20 million barrels more crude oil in 1975 than in 1974.

DRILLING ACTIVITY

Drilling activity in 1975 had 23,988 successful oil and gas well completions, an increase of 20%. There were 16,408 oil wells completed in 1975, a 28% increase of 3,624 wells. Gas well completions were 7,580, 5% above the 1974 results.

Development well completions, both oil and gas, increased 21% above 1974 levels and accounted for 21,845 wells, or 91% of the total well completions in 1975. Of 21,845 well completions, 15,436 were completed as oil wells, a 29% increase over 1974. More than 6,000 (37%) of the total successful oil wells were completed in Texas. California was second in importance with 1,854 oil well completions,

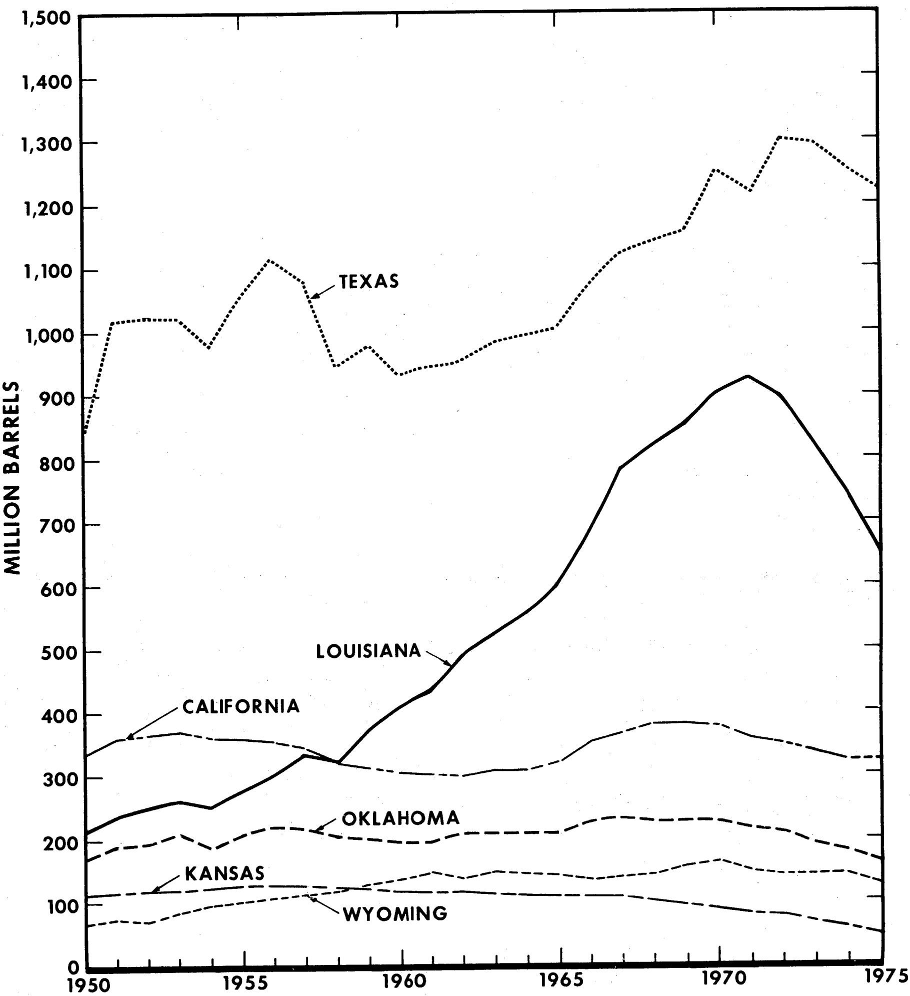


Figure 2.—Production of crude petroleum in the United States, by principal producing States.

and in Oklahoma, 1,743 oil wells were completed.

Development oil well completions for 1970–75 are shown in the following tabulation, by quarter:

There were about 500,333 oil wells producing at the end of 1975, compared with 497,631 at yearend 1974. This was a continued increase in the number of oil wells producing. Production of all produc-

Year	January–February	April–June	July–September	October–December	Total
1970 ----------	3,088	2,943	3,115	3,125	12,230
1971 ----------	2,804	2,679	2,617	3,089	11,207
1972 ----------	2,789	2,729	2,664	2,452	10,622
1973 ----------	2,310	2,093	2,333	2,542	9,283
1974 ----------	2,417	2,949	3,196	3,396	11,970
1975 ----------	3,515	3,270	3,755	4,868	15,436

Source: Quarterly Review of Drilling Statistics for the United States. American Petroleum Institute, Washington, D.C.

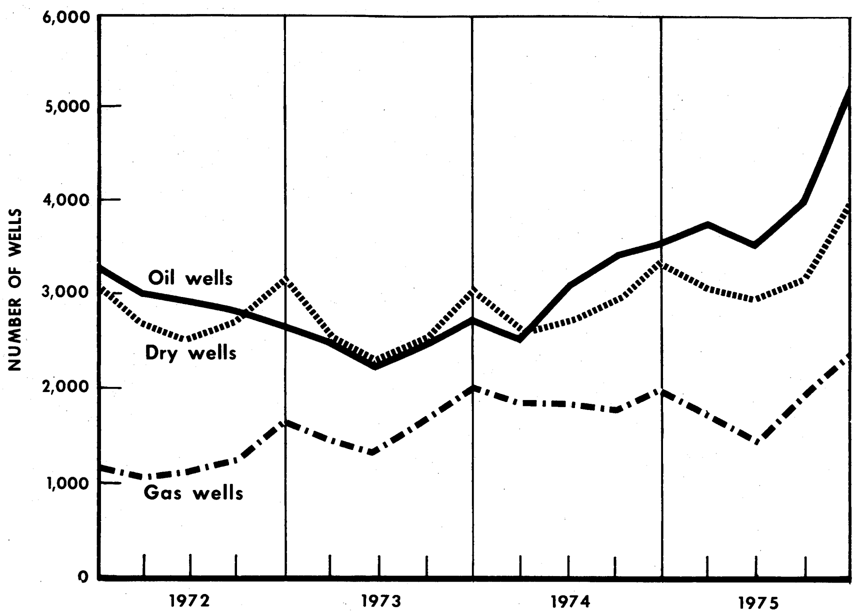


Figure 3.—Wells drilled for oil and gas in the United States, by quarter.

ing oil wells averaged 16.7 bpd in 1975, compared with 17.6 bpd in 1974.

Stripper wells, which are wells producing 10 bpd or less of oil, at the end of 1975 numbered 367,872, or 73.5% of all oil wells, according to the National Stripper Well Survey, a joint project of the Interstate Oil Compact Commission and the National Stripper Well Association.

Stripper wells recovered oil from 9,218,949 acres and accounted for 394,162,941 barrels of the total domestic crude oil output in 1975. Average production per well was 2.93 bpd. Stripper well abandonments totaled 13,478 in 1975.

RESERVES

The API Committee on Petroleum Reserves estimated recoverable reserves of crude oil as of December 31, 1975, to be 32,682 million barrels, a decline of 1,568 million barrels, or 4.6% for the year.

Gains in proved reserves occurred in six States, led by California, which added 90.5 million barrels. Losses in proved reserves occurred in 22 States. In those States with significant reserves, the largest losses occurred as follows (in million of barrels): Texas, 922; Louisiana, 400; Utah, 43; New Mexico, 37; and Wyoming, 26. A 5-year time series on proved reserves is available in table 12.

Indicated additional reserves from known reservoirs are those potentially available crude oil reserves in known reservoirs in excess of proved reserves. Engineering knowledge and judgment indicate that these additional reserves will be economically available by application of fluid injection and other improved recovery techniques. In addition to proved crude oil reserves, the API estimates indicated additional reserves to be 5,022 million barrels. Texas accounted for 1,867 million barrels, or 37.2%; California followed closely with 1,863 million barrels, or about 37.1%. Other States were New Mexico, 350 million barrels, or 7%; Oklahoma, 227.5 million barrels, or 4.5%; and Wyoming, 182 million barrels, or 3.6%.

CRUDE SUPPLY

Total receipts of crude oil at refineries in 1975 were 4,546.2 million barrels, or 12.5 million bpd, an increase of 110 million barrels, or 301,000 bpd. In 1975, refinery runs to stills increased 112.7 million barrels, or 309,000 bpd, as shown in table 19. Reflecting the continued phaseout of Canadian crude oil exports to the United States, overland receipts of crude oil from Canada declined 69.6 million barrels in 1975, or 24%, as shown in table 61. Conversely, imports of crude oil from Mexico jumped from less than 1 million barrels in 1974 to over 25 million barrels in 1975. Foreign receipts from overseas sources were up 229.0 million barrels, or about 627,000 bpd, and more than one-half of that increase originated in Africa as a result of Libya resuming exports of crude oil to the United States. Although the Arab oil embargo was lifted in the spring of 1974, Libya did not lift its restrictions on exports to the United States until early 1975. PAD district I, with refinery centers around New York Harbor and in the Delaware River Valley, received 30% of total crude oil imports, and PAD III, the gulf coast, followed closely with 29%. Refineries processed 4,541.4 million barrels (12.4 million bpd) of crude petroleum of which 67% was of domestic origin (table 19).

REFINED PRODUCTS

SUPPLY AND DEMAND

Demand for petroleum products averaged 16.3 million bpd in 1975, which was 2% below 1974 levels and about 1,017,000 bpd less than in 1973. Most of the decrease resulted from the mild 1974–75 winter season. Lower distillate fuel demand, coupled with decreased use of residual fuel oil and LP gases and a sharp decline in asphalt demand, more than offset the rise in motor gasoline demand during 1975.

MOTOR GASOLINE

Motor fuel demand, as estimated by the Bureau of Mines, averaged nearly 6.7 million bpd in 1975, which was about 2% above demand of 6.5 million bpd in 1974.

The Federal Highway Administration (FHA) also compiles data on gasoline consumption. These data, based on State taxation reports at the wholesale level, include highway use and nonhighway use of motor fuel and differ from Bureau of Mines estimates since only part of secondary stocks relating to independent bulk terminals are included in the Bureau's reports. Secondary stocks held by jobbers, dealers, service station operators, and consumers are excluded from the Bureau's calculations. FHA estimated that gross consumption of motor gasoline, for both highway use and nonhighway use, averaged 6,802,000 bpd in 1975, compared with 6,644,000 bpd in 1974 (table 23).

Federal Energy Administration (FEA) restrictions on motor gasoline which were under the Emergency Petroleum Allocation Act of 1973 (Public Law 93–159) were continued under the Energy Policy and Conservation Act (EPCA) which was enacted unto law (Public Law 94–163) on December 22, 1975.

AVIATION FUELS

Aviation Gasoline.—The downtrend in demand, which dates back a decade, continued in 1975. With the transition from piston to jet and propellerjet engines, demand shrank 76% from 120,000 bpd in 1965 to 38,540 bpd in 1975. Over this period, airline use of aviation gasoline as reported by dealers declined from 33,000 to 2,300 bpd and military use declined from 60,000 to 9,400 bpd. Military use accounted for 53% of shipments in 1965 and about 25% in 1975, as shown in table 26.

Commercial Jet Fuel.—By far, the greatest use of kerosine is in commercial kerosine-type jet fuel. This product is a kerosine with restrictions on the content of aromatics and naphthas as stipulated in ASTM–D 1655 specifications. The product has a very low freezing point and includes military JP–5 jet fuel.

Shipments of kerosine-type jet fuel recovered moderately in 1975 after a sharp drop in 1974 but were still below the levels of 1972 and 1973, reflecting in part at least the impact of the economic recession. Shipments kerosine-type for commercial use in 1975 averaged 715,000 bpd compared with 694,000 bpd in 1974 (table 26).

Production of the kerosine-type jet fuel averaged about 691,000 bpd in 1975, a 7.9% increase over 1974. At the same time

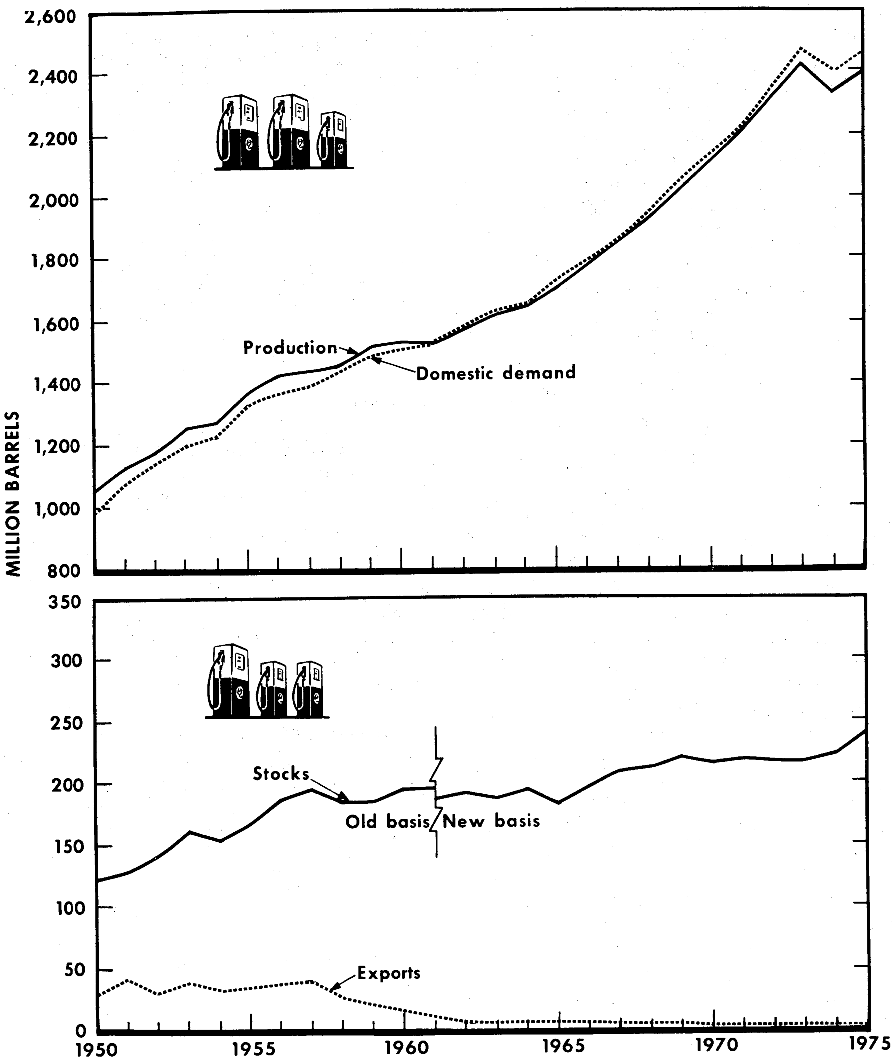


Figure 4.—Production, domestic demand, stocks, and exports of gasoline in the United States.

imports, were cut back about 23% (table 27).

The use of jet engines as gas turbines to generate electric power is expanding. Nearly 2.5 million kilowatts of capacity in gas turbine plants was either in the planning stage or under construction in 1975. Another 2.5 million kilowatts was scheduled for 1976. At the same time, however, the use of kerosine-type jet fuels is decreasing. Prices for kerosine-type jet fuel have increased more sharply than for No. 2 and No. 4 distillates so that utilities are using more distillates and have cut back on the use of commercial kerosine-type jet fuels as follows (thousand barrels):

1972	8,800
1973	6,300
1974	5,200
1975	3.200

Naphtha-type jet fuel shipments that are primarily for the military declined slightly in 1975 to 238,000 bpd from 249,000 bpd in 1974. In addition, the military imported in 1975 an additional 10.2 million barrels; in 1974, direct imports totaled nearly 8 million barrels.

Naphtha-type jet fuel is in the heavy naphtha boiling range with an average gravity of 52.8° API and 10% to 90% distillation at 210° F to 420° F and conforms to ASTM–D 1655 and military specifications MIL–F–5624 and MIL–T–56246. It includes military jet fuel, JP–4.

The allocation program and price controls administered by the FEA have been changed. Controls on naphtha-type jet fuel have been lifted by FEA, but controls remain on kerosine-type jet fuel and aviation gasoline.

LIQUEFIED GASES, ETHANE AND ETHYLENE

Liquefied gases are derived from two sources; those produced at refineries are called liquefied refinery gases to distinguish them from liquefied petroleum gases obtained by processing natural gas. The liquefied petroleum gases (LPG) are all paraffins (propane, butane, and isobutane). The liquefied refinery gases (LRG) also contain paraffins but may also contain unsaturated hydrocarbons; that is, the olefins (propylene, butylene, ethylene, etc.). The paraffins may be used as fuel (including as a blend with motor gasoline) or as feedstock at petrochemical plants. The olefins are used primarily as petrochemical feedstocks.

Demand for ethane (including ethylene) declined nominally in 1975. Ethane is used primarily to make ethylene, a building block for petrochemicals.

Domestic demand for LPG and LRG in 1975, excluding that blended into other products at refineries or terminals, was nearly 1 million bpd, compared with 1.1 million bpd in 1974. Propane accounted for 79% of liquefied gas demand in 1975, but if refinery propane and proyplene is deducted the percentage shrinks to 56%.

Propane was available during the heating season because of the combined effects of allocation, high prices, mild winter weather, and the economic recession. Furthermore, stocks of plant propane totaled 64.8 million barrels at yearend, which was 8% more than 1973 stocks. In 1975, however, production of propane and other natural gas liquids was affected by the decline in natural gas production.[5]

Demand for plant propane declined 5.7% to 554,923 bpd. Production at gas processing plants in 1975 declined only 2.9%, so by the end of 1975 there was a buildup in stocks at plants to 76 million barrels, or 17.4% above the 64.8 million of a year earlier.

Mandatory propane allocation and price controls administered by the FEA continued in 1975. The establishment of new base prices resulted in a lower 1975 average unit value.

Presidential Proclamation 4317, dated September 24, 1974, provided for the tariff fee on natural gas liquids (NGL) imports (excluding propane) to increase to 18 cents per barrel from 15.5 cents per barrel effective May 1, 1975. However, Presidential Proclamation 4341, dated January 23, 1975, estimated a tariff fee of 21 cents per barrel on NGL imports (excluding propane) effective February 1, 1975.

KEROSINE

A mild 1974–75 heating season was reflected in a 9.9% decline in demand for kerosine in 1975. Demand dropped from 176,300 bpd to 158,900 bpd. In 1975, refineries produced kerosine at an average rate of 159,000 bpd, which was only slightly below 1974 daily production of 155,000. FEA allocation regulations applicable to kerosine were withdrawn by FEA. About 78% of the domestic demand for kerosine (including range oil) is for space heating. Domestic demand for kerosine has been in a downtrend for many years. However, this trend could be arrested if present users decide against converting to other forms of energy such as LPG and electric power because of sharp increases in prices.

DISTILLATE FUEL OIL

When produced by conventional distillation procedures, distillate has a boiling range from 10% at 300° F to 90% at

[5] Data are available for 1975 in the following Bureau of Mines Mineral Industry Surveys: Natural Gas, Monthly; Natural Gas Liquids, Monthly; and Petroleum Statement, Monthly; and also in the Bureau of Mines Minerals Yearbook Chapter on Natural Gas Liquids.

675° F. Included are Nos. 1 and 2 heating oils and diesel fuels. No. 4 fuel oil, which is a blend of distillate fuel oil and residual fuel oil, is used extensively in smaller industrial plants because it does not require preheating.

The decline in general business activity coupled with a mild 1974–75 winter season resulted in 3.5% decline in demand for distillate from 2.9 million bpd in 1974 to 2.8 million bpd in 1975. The sharpest decline (23%) occurred in the use by electric utilities, from 232,000 bpd in 1974 to 178,600 bpd in 1975. Likewise, use by the railroads dropped from 282,000 bpd in 1974 to 255,000 bpd in 1975, or 9.5%. Trends in distillate fuel sales for the 1971–75 period are shown by end-use sector in table 31.

Electric utilities used significant quantities of distillates in their gas turbines and internal combustion generating equipment as shown in the footnotes to table 31.

Stock levels were more than ample so that production of distillates by refineries were cut back slightly as indicated in table 32. However, imports were reduced 47% to some 153,300 bpd in 1975 from about 289,300 bpd in 1974. With supplies returned to normal levels, the FEA relaxed its controls on distillate fuel oils but retained the authority to re-impose regulations if they consider it necessary.

RESIDUAL FUEL OIL

Residual fuel oil demand, sensitive to the general level of industrial activity, dropped in 1975 by 206,000 bpd, or 7.8% below 1974 levels (table 33). The use of residual fuel by electric utility companies accounted for over one-half of total use. Heating accounted for 17.3% and industrial use for 12.5%. Utility use in 1975 declined only 4.3%, but industrial use dropped nearly 22% and heating use declined 10%.[6] During 1975, there were two significant developments related to residual fuel oil. The first was the 15% increase in production by U.S. refineries. Secondly, domestic production of residual fuel oil in 1975 exceeded imports for the first time since 1963. Residual fuel oil with a sulfur content of 1.00% or less accounted for 604,000 bpd, or 49% of production. About 338,000 bpd, or 27%, had a sulfur range from 1.01% to 2.00%. Imports in 1975 averaged 1.2 million bpd compared with 1.6 million bpd in 1974, a drop of 25%. Nearly one-half of residual fuel oil imports were received into the Central Atlantic States, and 57.6% was in the low-sulfur range of 0% to 0.50%.

With production up sharply and demand down nearly 8%, by yearend 1975, stocks had built up to levels nearly 7% above those of 1974. Stocks at yearend 1975 were equivalent to a 27-day supply compared with a 20-day supply at the end of 1974. This improvement in supply induced the FEA to relax controls on residual fuel oil similar to the action taken on distillate fuel oil. The FEA, however, reserved the authority to re-impose price and allocation controls if necessary to attain the objectives of the Emergency Petroleum Allocation Act of 1973 (EPAA). This is similar to the authority retained for distillate fuel oil.

OTHER PRODUCTS

Petrochemical Feedstocks.—In 1975, petroleum refineries produced nearly 122.2 million barrels of petrochemical feedstocks. Domestic demand approximated 116.8 million barrels, which was 15.7 million barrels, or nearly 12%, below the 1974 levels as shown in table 35. Naphtha-400° constituted nearly 46% of demand in 1975 (Table 22).

Special Naphthas.—Special naphthas are used primarily as paint thinners, cleaning agents, and solvents. In 1975, as shown in table 34, domestic demand was 27.5 million barrels, a drop of nearly 4.5 million barrels, or 14% below the 32.0 million barrels in 1974.

Lubricants.—Total demand for lubricants in 1975 dropped nearly 12% to 50.2 million barrels from the near 56.7 million in 1974. Exports fell 24% to 9.1 million barrels and domestic demand declined 6.5 million barrels, or 11.5%, as indicated in table 36.

There are 44 refineries in the United States and 1 in Puerto Rico with a finished lubricant manufacturing capacity of 227,650 bpd. This is only 13,200 bpd higher than the capacity levels which prevailed at the beginning of 1970. This modest 1.2% growth rate is understandable. The

[6] U.S. Bureau of Mines. Sales of Fuel Oil and Kerosine in 1975. Mineral Industry Surveys, Sept. 17, 1976, 14 pp.

United States dominated the lubricants industry, producing 80% and consuming 60%. Exports were the prime outlet into the 1960's but between 1967 and 1975 exports decreased because construction of refineries in foreign countries was gathering momentum and many of these plants included facilities to manufacture finished lubricants. Exports from the United States dropped from 51,200 bpd in 1967 to nearly 25,000 bpd in 1975, or 51.3%. With demand down and exports declining, production dropped 20.5% in 1975. Lubricant-producing facilities operated at 67.6% of capacity in 1975.

Waxes.—Demand for waxes slackened in 1975 to 6,076,000 barrels or 16,600 bpd, a decline of 10.7% from the 18,600 bpd of 1974 (table 37). The economic recession and the decline in business were reflected in weak wax demand for 1975. With the recovery evidenced subsequently, there has been some improvement in demand, both in total and domestic. Paper converting accounts for about one-half of wax end use.

Petroleum Coke.—Petroleum coke is reported by the Bureau of Mines as catalyst coke and as marketable coke; catalyst coke is a noncommercial coke, which cannot be recovered and marketed because it forms on the catalyst during the cracking of charging stock in the cracking unit of a refinery. This carbon is burned off the catalyst in the regenerator section of a cracking unit, and the coke is used as a refinery fuel without ever being seen. However, production of catalyst coke is shown in order to complete a supply and demand balance.

Production of both catalyst coke and marketable coke totaled 129,241,000 barrels in 1975, a 4.4% increase over that of 1974. About 51% of production, or 66.5 million barrels, was marketable coke. Exports of petroleum coke, however, declined in 1975 to 37.3 million barrels, or 9.8% below the 41.2 million barrels exported in 1974, as shown in table 38.

Nearly 25% of exports (9.2 million barrels) went to Japan, a decrease of 25% from the 12.3 million shipped in 1974. Exports to Canada also decreased 11.5% from the 5.2 million barrels shipped in 1974. Shipments to Europe were up slightly as a sharp rise in shipments to the Netherlands offset declines to West Germany and to Denmark, as indicated in table 59. Other changes between 1974 and 1975 are shown in table 59. Volumewise, marketable petroleum coke is our largest petroleum product export. It accounted for about 50% of the 74.3 million barrels of petroleum products exported in 1975.

Marketable coke may be raw or green coke or it may be calcined; that is, put through a roasting process in the presence of a flame to drive out the volatile impurities. There are three main outlets for marketable petroleum cokes: (1) Use as fuel, (2) manufacture of carbon products such as electrodes for metallurgical furnaces and silicon carbide abrasives, and (3) export. Calcined petroleum coke is used as a conductor at elevated temperatures by aluminum and steel companies and it is usually purchased on a custom basis. There is virtually no spot market for petroleum coke. Most calcined petroleum coke plants are located adjacent to petroleum refineries. Estimated production of calcined petroleum coke in 1975 was 6,650,000 short tons, or nearly 4% higher than in 1974.

Asphalt and Road Oil.—As a result of a continued slackening in road construction, asphalt and asphaltic products shipments in the United States in 1975 declined 11.1% from 31.0 million short tons (5.5 barrels=1 short ton) to 27.6 million short tons.

Sales of petroleum asphalt paving products for consumption in 1975 decreased 12.8% from 24.6 million short tons to 21.5 million short tons in 1975. Sales of petroleum asphalt roofing products at 4.8 million short tons in 1975 were only nominally below the 1974 results. Sales of such as asphalt cements and fluxes dropped 12.4% to 22.0 million short tons in 1975 from 25.1 million short tons in 1974.[7] Comparisons for 1974 and 1975 are also shown in table 39.

Production of asphalt also declined from 29.9 million to 26.2 million short tons, or 12.3%. With demand down, stocks increased 6.7% in 1975 (table 40).

Domestic demand for road oil in 1975 totaled 991,00J short tons, 20.8% less than in 1974 (table 40). Production declined slightly, but with demand reduced, inven

[7] U.S. Bureau of Mines. Sales of Asphalt in 1975. Mineral Industry Surveys, July 19, 1976, pp. 6.

tories increased again in 1975. Trends in demand for asphalt and road oil over the 5 year span 1971–1975 are also available in Table 40.

Still Gas.—Still gas is a mixture of extremely low-temperature-boiling hydrocarbons produced during the distillation of crude oil and may be used as refinery fuel and/or as a petrochemical feedstock. During 1975, refineries used 175.4 million barrels of still gas as fuel, a nominal decrease from the 175.7 million barrels consumed in 1974.[8] Consumption of still gas as a petrochemical feedstock increased 9%, to 15.7 million barrels from 14.4 million barrels in 1974, and the uptrend continued in 1976.

Miscellaneous Finished Oils.—The petroleum industry produces a variety of miscellaneous products that are sold directly to consumers or in bulk to specialty companies, that package and distribute them under various trade names. Included in this category would be absorption oils, specialty oils such as hydraulic and insulating oils, medicinal oils, rust preventives, sand face, spray oils, and others. Also, synthetic natural gas (SNG) feedstock is included in this grouping. Production of miscellaneous finished oils in 1975 was about 32.2 million barrels, a gain of 27.6% over the 25.2 million barrels produced in 1974. Production of absorption oils increased nearly 29%, but the production of "other products," which includes SNG feedstocks, increased nearly threefold, from 3.8 million barrels in 1974 to 11.1 million in 1975 (table 42).

Unfinished Oils.—Unfinished oils are oils that have been partly refined and will be further processed by refiners; examples are unfinished naphtha, gas oil, virgin- or straight-run naphtha, topped crude, and cracking stocks. The rerun (net of unfinished oils) represents the receipts of domestic or foreign oil plus or minus changes in stocks.

TRANSPORTATION AND DISTRIBUTION

INTERDISTRICT MOVEMENTS

A transportation system comprised of pipelines, tankers, barges, tank cars, and to a lesser degree, tank trucks moves crude petroleum to refineries for processing. Refineries received 67.3% of their crude oil requirements by pipeline, 30.9% by water, and 1.8% by tank cars and trucks in 1975 (table 43).

Data collected on receipts of domestic and foreign crude petroleum at refineries in the United States show receipts from local production (intrastate), receipts from other States (interstate), and receipts of imported crude. These data, by method of transportation, indicate the final receipts by water, pipeline, tank car, and truck. Receipts of domestic crude by water usually are moved by pipeline from the point of production to the point of water shipment.

Refinery receipts of crude oil carried by tankers and barges totaled 1,406 million barrels, or nearly 3.9 million bpd in 1975. Some 78% of receipts by water was of foreign origin in 1975 compared with 72% in 1974. In 1971, foreign accounted for 37%. A 5-year series of receipts is shown in table 43; details on interdistrict movements by tanker and barge are given in tables 44 and 45.

The 17 States comprising PAD district I accounted for 36.3% of domestic product demand. Foreign oil accounted for 88% of refinery output in district I. Of the remaining 12% some 152,200 bpd was received primarily from district III. In district III, domestic oil made up 78% of crude oil input to refineries. In 1975, 42% of crude input to refineries in the entire United States was in district III. Output of refined product in district III exceeded demand by a wide margin; hence, the extensive movement from district III to other districts. The transportation of petroleum products by months by pipeline between PAD districts is shown in table 46. During 1975, the pipeline movement of motor gasoline from district III to district I averaged 968,000 bpd; during 1974, it averaged 880,000 bpd, a 10% increase.

Refined products produced at refineries in PAD district V in 1975 represented 91% of the domestic product demand for that district. Domestic crude oil produced pri-

[8] U.S. Bureau of Mines. Crude Petroleum, Petroleum Products, and Natural Gas Liquids, Mineral Industry Survey, April 1976 issue, released Aug. 8, 1975, 30 pp.

marily in California supplied 56% of refinery input, and of the 44% of oil imported one-third originated in Indonesia and nearly one-third came from the Middle East. Canada was an important supplier of crude oil for district V, particularly for those refineries in the Puget Sound area of Washington. The phaseout, however, of crude oil exports to the United States, which was enacted by the Canadian National Energy Board (NEB) in 1973, has caused sharp reductions in exports to the United States, from about 242,000 bpd in 1973 to some 163,000 bpd in 1975. Under the original NEB formula, crude oil exports to the United States would have been completely phased out by the end of 1981, but with the Sarnia-Montreal pipeline becoming operational there is a strong likelihood that Canadian oil exports to the United States will phase out by the late 1970's except for heavy crude oils. A similar action has been taken by NEB on natural gas exports to the United States, which are expected to end by 1984.

There are, however, a number of new sources of oil and these could more than supply sufficient crude oil for needs of refineries in PAD district V and, at the same time, provide an excess to meet, in part at least, crude oil needs in the Midwest PAD district II and perhaps PAD district III. These are (1) Alaskan oil, (2) oil from Naval Petroleum Reserve No. 1 (NRPNO1) at Elk Hills, Calif., and (3) the offshore fields in the Santa Barbara Channel. Alaskan oil from the North Slope (Prudhoe Bay) is expected to start moving south through the Trans Alaska Pipeline to Valdez for tanker shipment to the west coast in August 1977. In NPRNO1, extensive drilling and development began in mid–1976, as directed in Public Law 94–258 enacted April 1976. The Canadian crude oil export phaseout is also having a drastic impact on "Northern Tier" refineries.

PIPELINES

Crude oil pipelines delivered 3,060 million barrels, or 8.4 million bpd, to refineries in 1975, a decrease of 2% from the 8.6 million bpd in 1974 (table 43). Petroleum product pipelines delivered 3,272.2 million barrels, or an average of 8,965,000 bpd in 1975, compared with 3,225.2 million barrels, or 8,836,000 bpd, in 1974. Transportation by pipeline of petroleum products between PAD districts is shown in table 46. Transportation and stocks in lines and working tanks is available in table 49; tariff rates appear in table 48.

RAIL, TANK TRUCK, BARGE, AND TANKERS

The annual study of the Association of Oil Pipelines estimated that the total tonnage of crude oil and petroleum products carried was 1,874 million short tons in 1974. Of this total, 47% was transported by pipelines, 22% by water carriers, 29% by motor carriers, and 2% by railroads. On an overall basis, volumes transported in 1974 were 4% greater than those in 1972. Petroleum products accounted for 67% of the volume transported.

Product pipelines transport only the light products such as gasoline, light fuel oils, heating oils, LPG, kerosine, and jet fuel. These lines transported 1,253.5 million short tons, or 33.5% of the total. Motor carriers transported some 482 million short tons, or 38.45% of the petroleum products carried. In terms of billions of ton-miles, the total aggregated 489.6, of which 41.9% was transported by pipelines, 49.8% by water carriers, 5.4% by motor carriers, and 2.9% by railroads. Total crude petroleum carried in domestic transportation, was 356.8 billion ton-miles in 1974. Pipelines accounted for 84.4%, water carriers 14.8% and motor carriers and railroads 0.8%.

Deepwater Ports.—A tanker voyage from the Middle East to the U.S. east coast involves a 24,000-mile round trip, and use of very large crude carriers (VLCC's) could reduce transportaion costs markedly if deepwater ports were available. Many tankers in use today are VLCC's, and virtually all of these ships are unable to enter ports with a depth under 75 feet. At present, there are no United States ports capable of accommodating VLCC's with capacities greater than 200,000 deadweight tons (dwt). The deepest ports in the United States are on the west coast and can handle tankers up to 150,000 dwt. Most harbors in the United States are limited to ships with capacities ranging from 40,000 to 70,000 dwt.

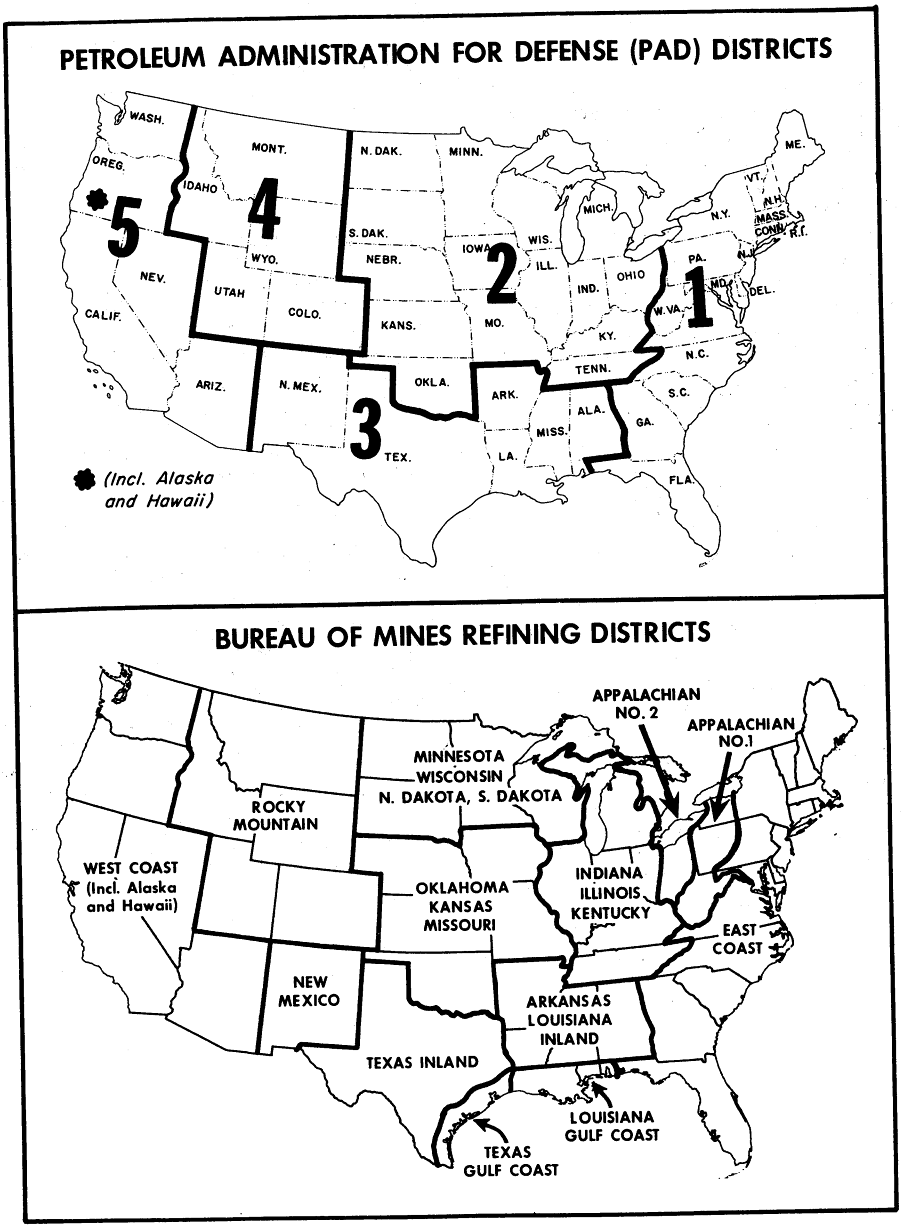


Figure 5.—Maps of Petroleum Administration for Defense (PAD) districts and Bureau of Mines refining districts.

The Deepwater Port Act of 1974, signed by the President, provided for licensing and regulation of deepwater ports. The Secretary of Transportation is empowered to grant licenses for ownership, construction, and operation of deepwater-port facilities. At the same time, a Governor of an adjacent State located within 15 miles of a deepwater port or connected directly by pipeline to a deepwater port could veto the project.

Two corporations are planning to construct two deepwater ports—one 31 miles off the Louisiana coast at Grand Isle in water over 100 feet deep in the Gulf of Mexico, and the other off the Texas coast. At the Louisiana Offshore Oil Port (LOOP), the firm proposes to store imported oil in the Clovelly salt dome near Galliano, La. Proposed storage capacity of this facility is expected to be about 56 million barrels of oil. Seadock would be the second deepwater terminal, and it is proposed that it be constructed off the upper Texas gulf coast 25 miles south of Freeport. Storage facilities for Seadock will be located 5 miles inland and will consist of 28 tanks with a storage capacity of 22.5 million barrels.

Both of these applications are being considered by the U.S. Coast Guard, the agency authorized to review and issue permits and to monitor any deepwater terminals. If the permits are granted by mid–1977, the two terminals are expected to be on-line by 1980.

Oil off-loaded at such terminals would be transported to shore facilities by pipeline, thereby reducing the need to transfer oil cargoes from VLCC's to smaller vessels for transport to conventional terminals or refineries.

TANKER RATES

World tanker charter rates, after peaking late in 1973, have been in a downtrend. From $2.02 per barrel, charters in December 1973 for 34° crude oil for Large Range 2 tankers (80,000 to 159,999 dwt) dropped nearly 40% by December 1974 to $1.21 per barrel, for cargoes destined from Ras Tanura to New York via the Cape of Good Hope. Rates later firmed up, and at the end of 1975 were about $1.26 per barrel. Charters, same destination, for vessels of 16,000 to 24,999 dwt (classified as "General Purpose" tankers), dropped over the same 1973–74 interval from $3.23 per barrel to $2.63 per barrel. By yearend 1975, the rate for the smaller tankers, however, had rebounded to $2.90 per barrel. An oversaturation in tanker supply, particularly larger size tankers, has helped to weaken tanker rates. It should be noted, however, that average tanker charter rates move slowly since they include charters that run about 3 years. Also, much of the shipping moves in company-owned vessels.

STOCKS

Petroleum products stocks have been increasing steadily after reaching a low of 866.9 million barrels in February 1973. This was the lowest inventory position since February 1968 and close to stock levels during the 1967 Arab-Israeli conflict, which cut off imports from the Mideast. By yearend 1975, stocks of all oils had recovered to 1,133 million barrels, an increase of 60 million barrels over the end of 1974 as shown in table 49. Stocks of refined products were 52.8 million barrels higher at yearend 1975. Crude oil stocks, which shrank from 279.5 million barrels in May 1972 to a 7-year low of 235.4 million barrels in February 1973, climbed to a new record of 281.9 million by April of 1975. Stocks declined seasonally and at yearend 1975 aggregated 271.4 million barrels, a 6.3-million-barrel increase over the stock position of a year earlier.

STORAGE

The Arab Oil Embargo during the last quarter of 1973 and the first quarter of 1974 had a severe impact on the supply of oil needed to meet domestic demands. In an effort to diminish in the future the vulnerability of the United States to the effects of a severe oil supply interruption and to provide limited protection from the short-term consequences, Congress enacted legislation to establish a Strategic Petroleum Reserve (SPR) in Title I, Part B of the EPCA.

Under the initial phase of the SPR, referred to as the Early Storage Reserve (ESR), 150 million barrels of oil will be stored by 1978. Of the different types of storage facilities, existing solution-mined salt dome cavities are among the most attractive for petroleum storage because of the relative low cost of bulk storage and the extreme geological stability of the rock salt masses.

Under the EPCA the FEA is directed to pick the ESR phases of the program. Initially the FEA selected the eight sites listed below. From these, three will be finally selected for the ESR. Candidate sites are Bryan Mound, Brazoria County, Tex.; Cote Blanche Island mine, St. Mary's Parish, La.; Weeks Island mine, Iberia Parish, La.; West Hackberry Salt Dome, Cameron Parish, La.; Bayou Choctaw Dome, Iberville Parish, La.; Kleer salt mine, Van Zandt County, Tex.; and limestone mines near Central Rock, Ky., and Ironton, Ohio. Filling of storage will start about August 1977, at the rate of 40,000 to 50,000 bpd.

PRICES

Crude Oil.—The increase of the host countries' shares in oil participation from 25% to 60%, and in some countries complete nationalization, coupled with sharp increases in prices adopted by the Organization of Petroleum Exporting Countries (OPEC) in 1973 and 1974, caused consternation in oil-consuming nations throughout the world. These actions are discussed in the World Review section of this chapter. The uptrend in prices continued in 1974, but with economic recession worldwide and crude oil a glut on world markets, the climb in prices had been arrested as of mid–1975. Prices picked up momentum in October 1975, however, with a 10% increase announced by OPEC.

A large part of crude oil obtained from foreign countries is equity oil; that is, oil produced and owned by companies that had obtained concessions from host governments. In return, the companies were required to pay both a royalty and a tax on oil produced. The aggregate of tax-royalty and the cost to produce oil represented the total cost of equity oil and was termed "tax-paid cost." The royalty and tax were based on a posted price that was initially established by negotiation between the host country and the oil-producing company. More recently, however, the host government alone has established the posted price.

Prices continued to rise in 1975. The posted price for Arabian light crude oil as of October 1975 was $12.38 per barrel.

The average value of domestic crude oil at the wellhead, which was $3.39 per barrel in 1971, and 1972, increased to $3.89 in 1973, $6.74 in 1974, and $7.56 in 1975. These increases were the result of an effort to stimulate production of domestic crude oil by the Cost of Living Council (CLC) which on August 17, 1973, enacted a two-tier pricing system under phase 4 oil regulations. The system released from ceiling prices "new oil" (oil produced above 1972 levels) and made an adjustment for the remainder of current production. The price of new oil produced, which was not covered by the price ceiling, rose steadily to market levels. The ceiling price for domestic crude was about $1 per barrel below the world price at the time phase 4 rules were issued on August 17. Since then, however, world prices have increased sharply and so have prices for new or exempt oil; that is, oil exempt from price controls.

The price-regulating function of CLC was absorbed by FEA in March 1974, and FEA took over this work in May 1974. Between January and December 1974 the price per barrel rose from $9.82 to $11.08. The price of old oil rose from $3.90 per barrel in August 1973 to $5.03 (revised) in December. FEA revised its calculations so that the price of old oil was reduced from $5.25 per barrel to $5.03 per barrel. Shown on the next page are prices per barrel wellhead for old and new crude petroleum for the last month of each quarter in 1974 and 1975. Data through June 1976 are also shown to illustrate the impact of EPCA after January 1976. Domestic crude petroleum prices per barrel, as shown on the next page, have climbed 11.6% from a 1974 average composite price of $6.87 to a 1975 average of $7.67. Likewise, prices refiners must pay for crude oil, both domestic and foreign, have also risen due to refiner's acquisition costs. This cost is the price paid by refiners for domestic crude petroleum, unfinished oils and natural gas liquids and includes transportation costs from the wellhead to the refinery.

	Old	New	Domestic average
1974:			
March	$5.03	$9.88	$6.77
June	5.03	9.95	6.85
September	5.03	10.10	6.70
December	5.03	11.08	7.09
Average	5.03	10.13	6.87
1975:			
March	5.03	11.47	7.57
June	5.03	11.73	7.49
September	5.04	12.46	7.75
December	5.03	12.95	7.93
Average	5.03	12.03	7.67
1976:			
January	5.02	12.99	8.63
February	5.07	11.44	7.82
March	5.07	11.39	7.80
April	5.07	11.52	7.86
May	5.13	11.59	7.98
June	5.15	11.60	7.99

The following tabulation shows refiner's acquisition cost per barrel for imported oil, domestic oil, and a composite of both as maintained by FEA:

	Domestic	Imported	Composite
1974:			
March	$7.05	$12.73	$8.68
June	7.20	13.06	9.45
September	7.18	12.53	9.13
December	7.39	12.82	9.28
Average r	7.18	12.52	9.07
1975:			
March	8.38	13.28	9.91
June	8.33	14.15	10.33
September	8.49	14.04	10.79
December	8.66	14.81	10.98
Average	8.39	13.93	10.38
1976:			
January	9.14	13.27	10.76
February	8.67	13.26	10.54
March	8.48	13.51	10.44
April	8.66	13.39	10.63
May	8.56	13.20	10.53
June p	8.59	13.47	10.88

p Preliminary. r Revised.

A composite of refiner's acquisition costs of imported and domestic crude was $3.85 per barrel in May 1973. By December 1975, the price was $10.98 per barrel, nearly a threefold increase. The rise was due primarily to the increase in the cost of imported oil. The refiner's acquisition cost for imported oil rose from $3.92 per barrel in May 1973 to $14.81 per barrel by December 1975, nearly a fourfold increase.

Section 401 of EPCA amended the EPAA by adding a new section 8, which sets forth crude oil pricing policy. This policy required the President to adopt implementatory regulations designed to result in the maximum weighted average first sale price during the month of February 1976 of $7.66 per barrel as stipulated in the EPCA. In subsequent months the EPCA permits adjustments in the first sale price of domestic crude to take into account the impact of inflation as a production incentive. For example, if current production from a property exceeds 1972 base production control levels (BPCL) for the property, the excess production qualifies under the new regulations as "new" crude oil.

Entitlements.—The FEA continued its entitlements system under the Old Oil Allocation Program (CFR 211.67). Every refiner had to have an entitlement to process a barrel of old crude oil as a percentage of total crude processed (that is, the total runs to stills) of old oil, imported oil, and domestic exempted oil. Each month, FEA calculates the amount of old oil produced as a percentage of total crude oil processed. If, for example, the old-oil ratio was 40% and a refiner's old-oil ratio was 60%, this refiner would have to buy entitlements equal to 20% at prices set by FEA from those refiners with less than 40%. An entitlement purchased at $5.00 would entitle the purchaser to process 1 barrel of old oil at about $5.03 per barrel, so that the effective cost would be about $10.03 per barrel for the 20% over the old-oil ratio.

Data on prices of selected crude oils and products are given in tables 55 and 57.

In the United States, gasoline outweighs all other products in terms of volume produced and relative importance in the refinery mix. Prices of gasoline have continued upward. The average service station price of regular-grade gasoline (including taxes) has risen from 42.26 cents per gallon as of December 1, 1973, to 53.15 cents per gallon on December 1, 1974, and to 59.42 cents per gallon on December 1, 1975, according to Platt's Oil Price Handbook and Oilmanac, 1975 edition.

Shown in the following tabulation (in dollars per 100 gallons) are some comparisons in selected cities of prices of No. 2 home-heating oil between December 1972 and January 1976. These intervals indicate the impact of the passthrough policy on retail prices. Between January 1974 and January 1976 the U.S. average rose 26% from $32.89 to $41.46 per 100 gallons.

Standard metropolitan statistical area	December 1972	December 1973	January 1974	January 1975	January 1976
U.S. average	$19.72	$22.76	$32.89	$37.84	$41.46
Baltimore	19.33	26.64	31.18	36.60	41.02
Boston	20.40	30.44	32.90	40.06	42.49
Chicago-northwestern Indiana	18.65	27.01	31.66	33.96	43.73
Detroit	18.62	25.14	30.35	35.75	39.68
Milwaukee	18.93	27.85	31.23	36.58	40.07
Minneapolis-St. Paul	18.06	26.42	34.74	35.72	40.13
New York and northeastern New Jersey	20.40	33.41	36.90	40.04	34.82
Philadelphia	19.23	26.27	21.30	37.96	43.52
St. Louis	19.49	26.53	33.72	37.51	40.98
Washington, D.C	19.78	29.95	33.30	40.82	41.99
Seattle	22.17	27.28	33.50	38.20	44.93

Source: Bureau of Labor Statistics.

Residual Fuel Oil Prices.—The price of Bunker "C" fuel oil at New York Harbor has been in an uptrend since 1972; from $3.45 per barrel at the end of 1972, to $5.42 per barrel by December 1973. By December 1975, the price had more than doubled. The trend of Bunker "C" prices for 1964–75, inclusive, is shown in figure 7.

Unlike the use of Bunker "C" fuel, use of No. 6 residual fuel oil is restricted to 0.3% sulfur in many communities along the eastern seaboard. New York City is an example. The average price per barrel for No. 6 fuel oil in New York Harbor market since 1971 follows:

1971	$ 4.87
1972	4.66
1973	5.99
1974	14.11
1975	13.39

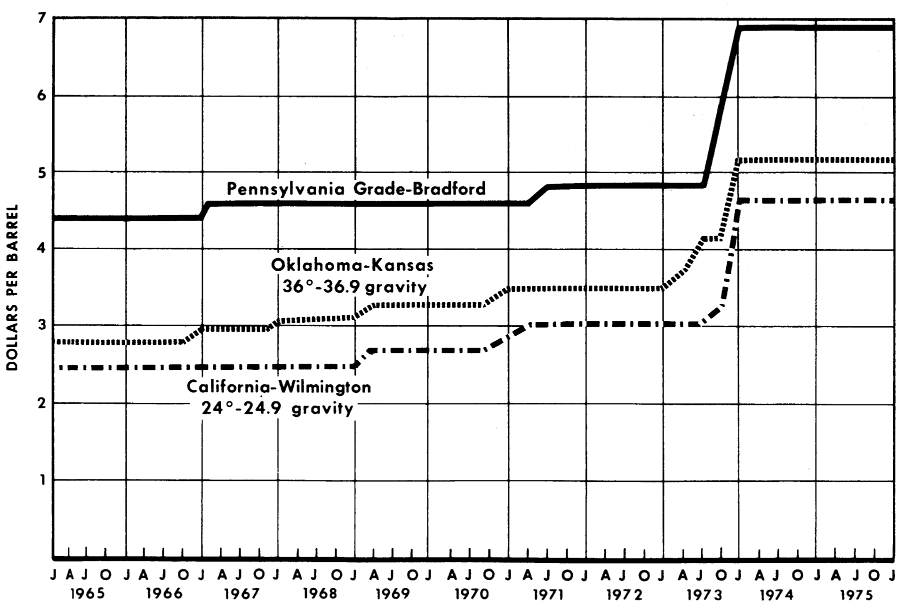


Figure 6.—Posted prices of selected grades of crude petroleum.

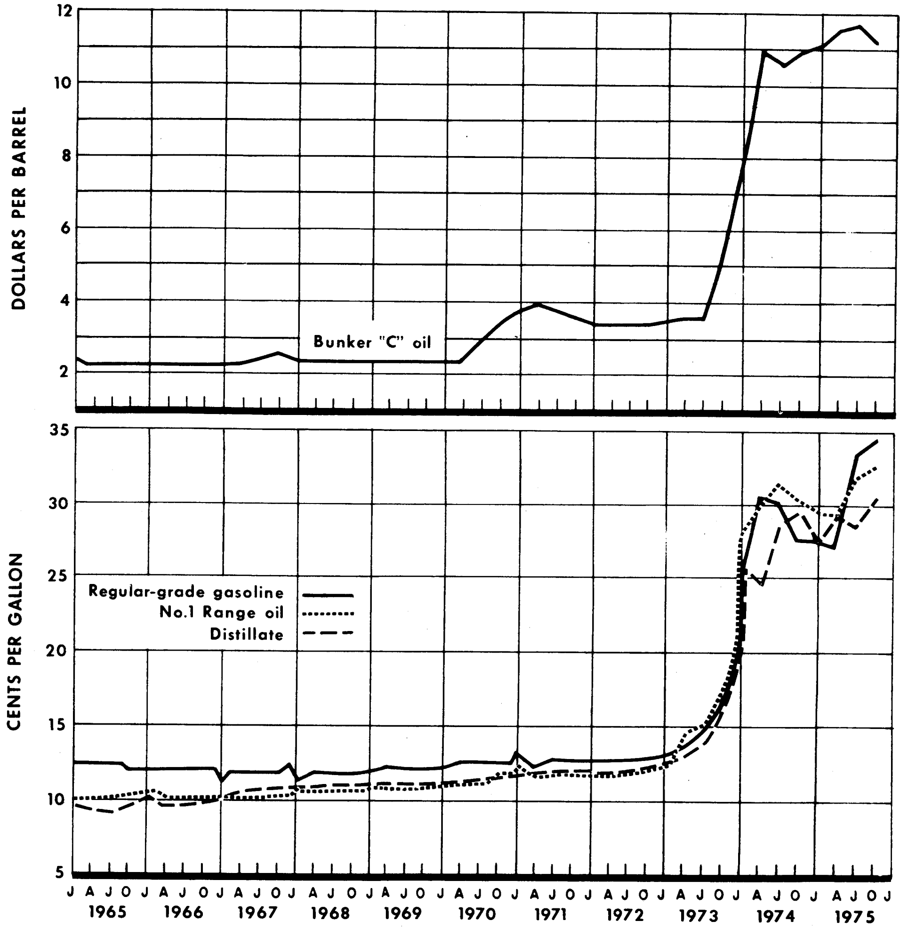


Figure 7.—Quarterly prices of bunker "C" and No. 2 distillate fuel at New York Harbor, No. 1 range oil at Chicago district, and regular-grade gasoline at refineries in Oklahoma.

FOREIGN TRADE

Exports.—Refined products exports declined 4.1 million barrels to 76.4 million barrels in 1975 as reductions in exports of coke, lubricating oils, and other products more than offset increases in residual fuel oils and petrochemical feedstocks. Exports of petroleum coke to Japan and West Germany declined sharply but exports to the Netherlands rose 51% to 7.1 million barrels. Exports by product and destination in 1974 and 1975 are shown in table 59.

Imports.—Imports of crude petroleum and refined products decreased a nominal 1.4% to about 2.2 billion barrels, or 6 million bpd, in 1975. Imports of crude in 1975 were 18% above those of 1974, but this increase failed to offset the 27% drop in the imports of petroleum products. Increasing sharply were crude imports from Venezuela, Saudi Arabia, Libya, and Nigeria. Also, imports from Mexico jumped from about 600,000 barrels in 1974 to more than 25 million barrels in 1975 (table 61). Conversely, imports from Iran decreased nearly 40%, from 463,000 bpd in 1974 to 278,000 bpd in 1975. As a result of Canada's planned cutback in crude oil exports to the United States, imports from that country dropped from 791,000 bpd in 1974 to 600,500 bpd or 24%.

Nigeria was the largest supplier of crude oil to the United States. Imports from that country averaged nearly 746,000 bpd in 1975, a 7% increase over the amount received in 1974. Imports of crude from Africa in 1975 averaged 1.3 million bpd, which was 19% larger than crude imports from the Middle East.

Imports of refined products in 1975 aggregated 1.9 million bpd, which was 27% below the 2.6 million bpd in 1974. Similar to the pattern of 1974, most of the decrease in 1975 was in the imports of residual fuel oil, distillate fuel oil, and kerosine-type jet fuel. In addition, imports of motor gasoline decreased almost 10% so that the drop in the four products aggregated 578,707 bpd, or 81% of the total decline in product imports which totaled 715,000 bpd. Moreover, of the decline of 578,707 bpd, residual fuel oil accounted for 392,433 bpd, or nearly 68%. Part of this decline in residual fuel oil imports reflects the reduced demand of 7.8% in 1975, but even more significant is the 15% increase in production of residual fuel oil by domestic refineries—from 1,070,000 bpd in 1974 to 1,235,000 bpd in 1975. Production of residual fuel oil by domestic refineries has not exceeded imports of that product since 1963. Production in the low-sulfur range (1.0% or less sulfur content by weight) increased 8.8%, averaging 616,000 bpd in 1975 compared with 566,000 bpd in 1974. Imports of low-sulfur fuel oils averaged 681,000 bpd, or nearly 24% below the 894,000 bpd in 1974. Comparisons of imports in 1975 and 1974 by country and by product are shown in table 61.

NATIVE ASPHALT

Bituminous Limestone, Sandstone, and Gilsonite.—Natural rock asphalt and limestone rock asphalt were produced in Alabama, Missouri, and Texas and were used for road-building material. Gilsonite was produced in Utah. The total production of native asphalts and related bitumens in 1975 was 1,901,715 short tons with a value of $19,838,000.

WORLD REVIEW

The world recession persisted throughout 1975 as petroleum-consuming nations attempted to adjust to the economic burdens resulting from a fourfold increase in crude oil prices by OPEC member nations. In view of reduced consumption following price increases during 1973–74 no further price increases were adopted by OPEC for the first 10 months of 1975.

The September meeting of OPEC, however, resulted in a 10% increase in the posted price of Arabian "marker" crude (34° API), thus raising the price from $11.25 to $12.38 per barrel effective October 1, 1975. Prices of most other OPEC crudes were, however, increased by less than 10%. For example, the price of Iranian light crude (34° API) was increased by 8.9%, Arabian heavy crude (27° API) by 8.5%, Qatar light crude (40° API) by 6.0%, and Indonesian Minas crude (35° API) by only 1.6%. Variable price increases were accepted within the OPEC structure by adjusting low-sulfur, gravity escalation, and location-advantage premiums.

Government revenues of OPEC member nations totaled an estimated $93 billion in 1975, a 3% increase over 1974 revenues. Increased revenues were realized in spite of reduced exports. When calculated on a per-barrel basis, OPEC revenues averaged an increase of 11%. Decreased per-barrel revenues were reported only by OPEC's African member nations. Libyan per-barrel revenues declined by nearly 13%, Nigerian by 4%, and Algerian by 3%. Revenue decreases for the African OPEC nations resulted from progressive price trimming in an attempt to reverse export declines in early 1975.

Governments of many oil-producing nations continued programs of increased participation in oil industry activities within their borders. During 1975, Iraq nationalized the remaining interests of the Basrah Petroleum Co., bringing that nation's petroleum industry under total Government control. Negotiations for total Government takeover of Kuwait Oil Co. were completed with National Assembly ratification anticipated early in 1976. December 31, 1975, marked the close of foreign company ownership in Venezuela's petroleum operations. State participation in petroleum operations remained at 60% in Saudi Arabia and in Qatar; however, both Governments anticipate a 100% takeover in 1976 with Qatar negotiating for a nationalization date retroactive to December 1974.

Government participation in other OPEC countries for the most part maintained a status quo. The Iranian Government, represented by the National Iranian Oil Co. (NIOC), exercised total control of onshore production representing more than 90% of that nation's output. Production from Iran's offshore wells is conducted by private companies in partnership with NIOC. Algeria's state-owned company Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures (SONATRACH) controls about 80% of the total petroleum production. A more liberal trend may be indicated by newly negotiated exploration-production contracts which obligate SONATRACH to reimburse private companies up to 15% of exploration costs on commercial discoveries, provide 51% of development costs, and participate in no more than 60% of production. Libya unilaterally announced a 51% takeover of petroleum operations in 1973. Any challenge to the government action resulted in total takeover by the Libyan National Oil Co. Indonesian operators recovered costs from 35% to 40% of production with remaining production shared on a 65% and 35% basis in favor of the state-owned petroleum company Pertamina. The respective Governments of Abu Dhabi, Oman, and Bahrain enjoyed a 60% participation in petroleum production operations within their boundaries. Nigerian Government participation continued on a 55% to 45% basis. Government participation in Ecuador remained at 25%. Gabon, which joined OPEC in 1975, as yet reported no Government participation in petroleum production.

The International Energy Agency (IEA) formed in late 1974 by oil-consuming nations[9] for the purpose of sharing energy resources in the event of another embargo and to promote international cooperation in developing alternative energy sources was joined by Norway and New Zealand in 1975, bringing the total number of participating countries to 18. During the year member nations agreed to increase their emergency petroleum stockpile reserve from a 60- to a 70-day supply by 1976, with a 90-day stockpile reserve set as a goal for 1980. Among the activities of the IEA in 1975 was the creation of an Industry Advisory Board[10] to provide advice on emergency petroleum sharing and to assure efficient execution of any emergency allocation program. Throughout 1975 extensive negotiations were conducted to establish a long-term cooperation agreement supporting a minimum price below which participating countries will not allow imported oil to be sold within their domestic economies. Negotiations neared a successful conclusion by yearend.

Production.—World crude oil and field condensate production dropped to 53.4 million bpd in 1975, representing a decline of 5% from 1974 production levels. Leading producers included the U.S.S.R. with a reported production of crude oil and field condensate averaging 9.9 million bpd, the United States averaging 8.4 million bpd, and Saudi Arabia averaging 6.8 million bpd.

Production from the 13 member nations of OPEC approached 27.2 million bpd, a reduction of 3.5 million bpd from 1974 output levels. OPEC production capacity is estimated at 37 million bpd. For the most

[9] Austria, Belgium, Canada, Denmark, West Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[10] British Petroleum, Ente Nazionale Idrocarburi, Exxon Corp., Gulf Oil Corp., Mobil Oil Corp., Österreichische Mineralölverwaltung, A.G., Petrofina, Petroleum Association of Japan, Petroleum Producers Association of Japan, Shell International, Standard Oil Co. (California), Standard Oil Co. (Indiana), Den Norske Stats Oljeselskap AS, Texaco Europe, Texaco Inc., Union Oil Co. of California, Veba-Chemie, A.G.

part, production cutbacks have been maintained to support higher price levels.

Production from non-OPEC nations averaged 26.2 million bpd in 1975 representing a production decline of 0.7 million bpd from the previous year's output levels.

Production declines were most evident in North America with U.S. production down by more than 0.4 million bpd and Canadian production down by nearly 0.3 million bpd. Any production growth among non-OPEC producers in the immediate future will stem from Mexico, the North Sea, and the Alaskan North Slope.

Approximately 1 out of every 7 barrels of oil produced in 1975 was obtained from an offshore field. Leading offshore producers were Saudi Arabia and the United States, each producing about 1.4 million bpd from offshore fields. Other major offshore producers were the United Arab Emirates, producing 0.6 million bpd, and Iran, producing in excess of 0.3 million bpd. Development activity in the North Sea continued with two fields in the British zone entering production in 1975. By 1976 production from the North Sea should average about 500,000 bpd.

Crude Oil Movements.—Crude oil constitutes about 80% of all Western European petroleum imports, nearly 90% of Japanese petroleum imports, and nearly 70% of petroleum imports of the United States. Crude oil movement to these major markets totaled more than 20.2 million bpd. Nearly two-thirds of these imports were obtained from the Middle East. Excluding intra-European shipments, Western European total crude imports averaged 11.6 million bpd with the Middle East supplying 8.5 million. Japanese crude imports from the People's Republic of China continued to grow, averaging nearly 158,000 bpd in 1975. The United States imported an average of 4.1 million bpd of crude oil. The leading suppliers to the United States were Nigeria, averaging 746,000 bpd; Saudi Arabia, 701,000 bpd; and Canada, 600,000 bpd.

Transportation.—A total of 326 new vessels representing a combined capacity of 44.3 million dwt was added to the world tanker fleet, while scrappings, conversions, and losses reduced the fleet by 291 vessels representing a combined capacity of 8.8 million dwt; at yearend 1975 the world tanker fleet comprised 3,674 vessels having a combined capacity of 291.4 million dwt. As a result of the reduced world demand for petroleum, surplus tanker capacity reached an estimated 115 million dwt at yearend.

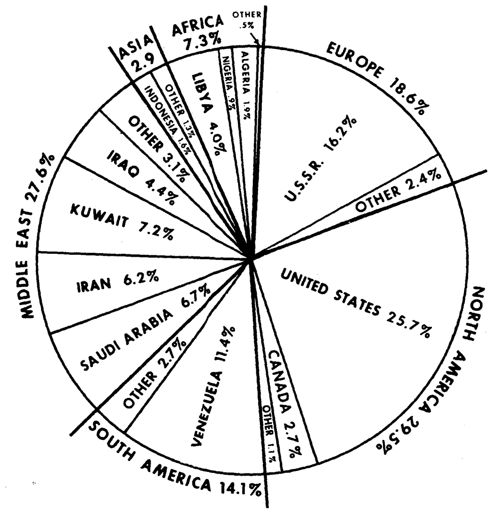
More than 30.7% of the world tanker fleet sails under the Liberian flag, 11.2% under the flag of the United Kingdom, and 10.9% under the Japanese flag. Tankers between 200,000 and 285,000 dwt constitute 40% of the total tanker fleet; tankers between 125,000 and 200,000 dwt constitute 10%; while tankers between 65,000 and 125,000 dwt constitute 20%.

Voyages from the Middle East occupied an estimated 75% of the oceangoing fleet. Voyages from the Middle East to Europe alone occupied about 50% of the total oceangoing fleet. During 1975, tanker movements on the Mediterranean Sea were diminished with the closure of the Tapline export terminal at Sidon, Lebanon. Reduced tanker rates afforded a savings of $1.50 per barrel on crude shipped to Europe via the Persian Gulf as opposed to the more expensive overland route to the Mediterranean Sea. Tanker traffic in the Mediterranean Sea, however, did increase in the last half of 1975 as a result of the reopening of the Suez Canal in June. Draft limitations of the canal permit passage of laden tanker of no more than 40,000 dwt. Laden tankers represented only 6% of the Suez Canal traffic in 1975. The Suez Canal can accommodate tankers of up to 100,000-dwt capacity if the vessel is passing through the canal in ballast. Tankers returning to the Persian Gulf in ballast represented 20% of the Suez Canal traffic in 1975.

Most United States east and gulf coast ports can only accommodate tankers of 70,000 dwt or less. Without lightering and transshipment facilities, importers could not benefit from the economic advantages realized in utilizing very large crude carriers for long-distance hauls. Transshipment terminals are operating at Grand Bahama Island and at Curacão. At yearend, a transshipment terminal was nearing completion at Bonaire, Netherlands Antilles. The terminal will be in service early in 1976.

Refinery Capacity.—Total world crude refinery capacity was estimated at 71.8 million bpd at yearend 1975, an increase of

1965-11.1 Billion Barrels



1975-19.5 Billion Barrels

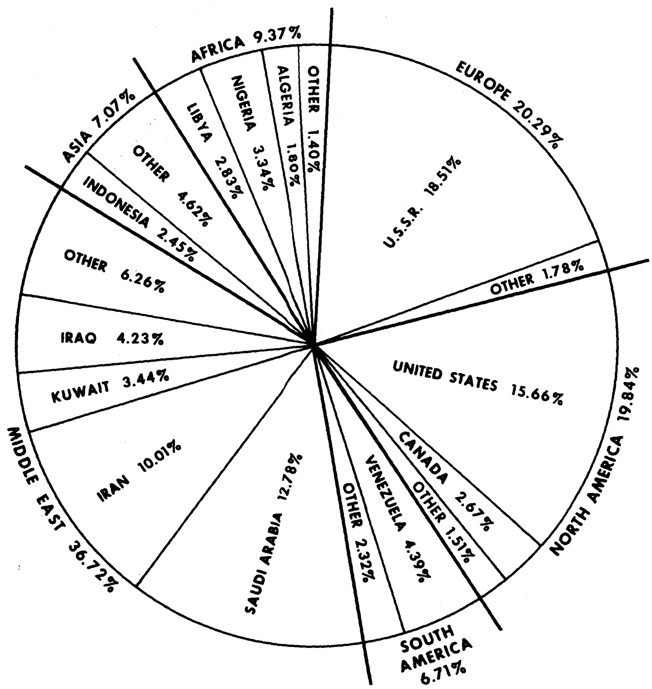


Figure 8.—World share of crude oil production in 1965 and 1975.

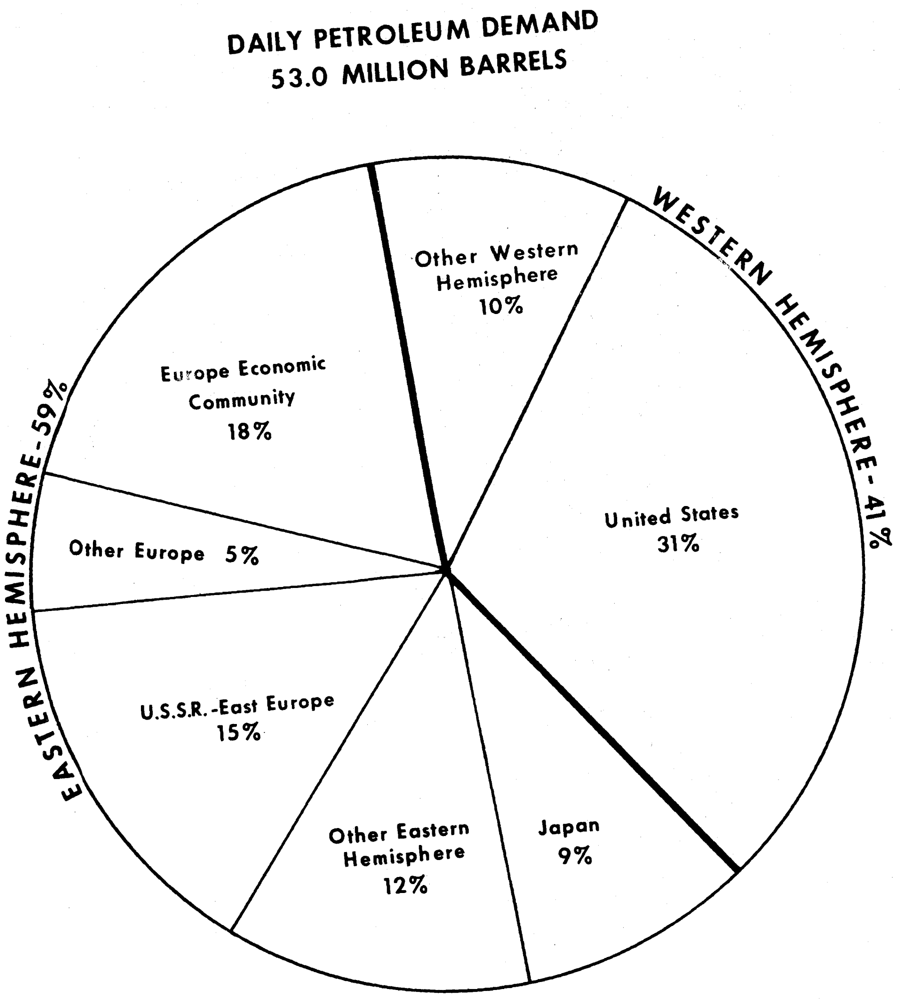


Figure 9.—World daily petroleum demand in 1975.

3.8 million bpd over 1974 levels. The Eastern Hemisphere with major refining centers in Western Europe, the U.S.S.R., and Japan accounted for nearly 65% of the total world refining capacity, or about 47 million bpd. As a result of reduced demand, most refineries operated well below capacity levels. In Western Europe crude oil and blendstock throughput represented only 60% of refining capacity. Japanese refiners operated at 80% capacity, and the U.S.S.R. refineries operated near capacity levels. Refining capacity in the Western Hemisphere totaled 24.8 million bpd; refining capacity of the United States was 15 million bpd, followed by Canada at 2 million bpd and Venezuela at nearly 1.5 million bpd.

Consumption.—World petroleum consumption declined to 53 million bpd in 1975 as a result of continued high prices. Consumption levels in major industrial areas continued to decline; Western European consumption was down to 12.2 million bpd, U.S. consumption was down to 16.3 million bpd, and Japanese consumption was down to 4.8 million bpd. Western European

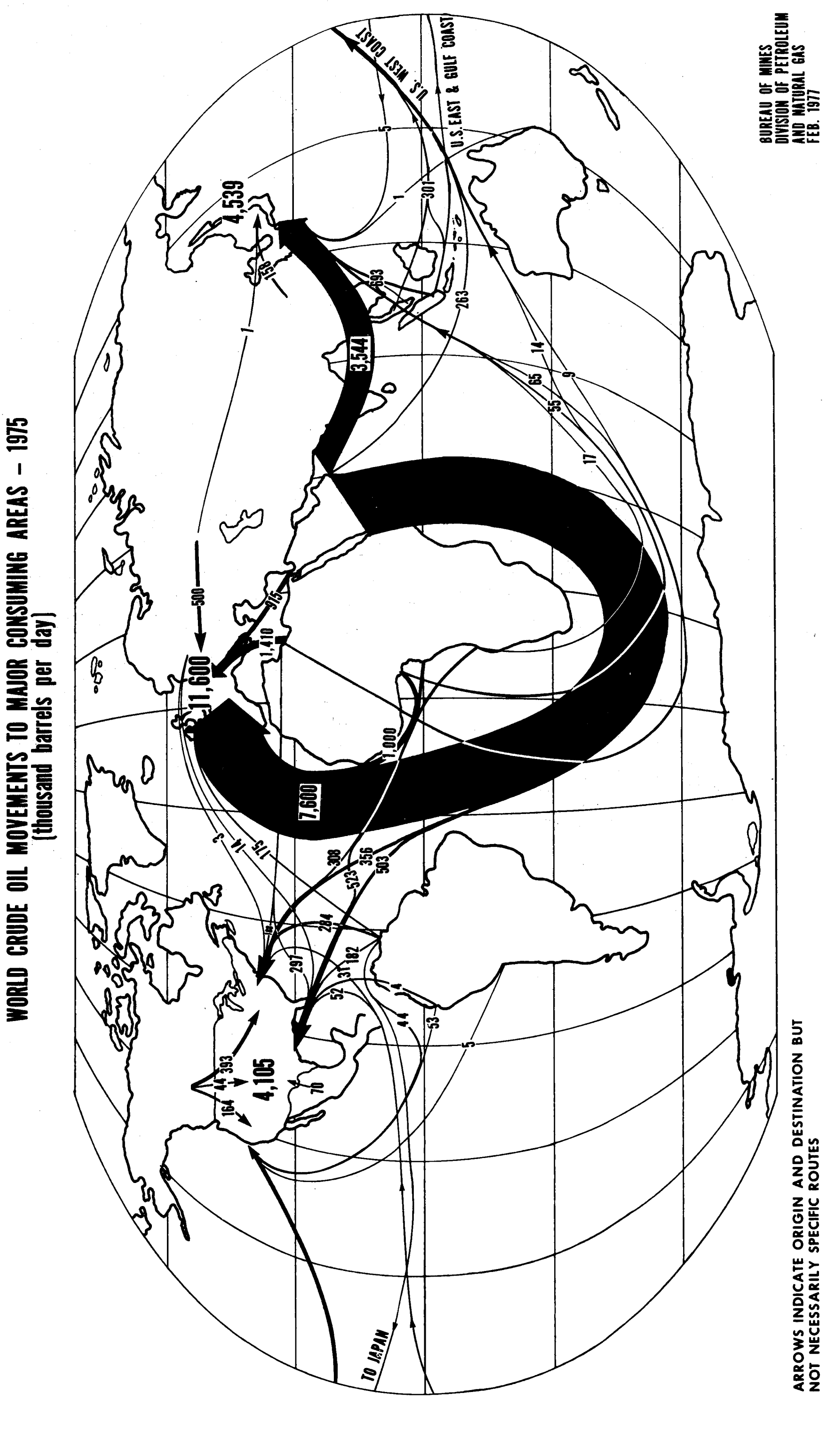


Figure 10.—World crude oil movements to major consuming areas in 1975.

consumption was reduced by 1.8 million bpd; U.S. consumption by 0.3 million bpd; and Japanese consumption by 0.8 million bpd compared with 1974 consumption levels.

Algeria.—The slowdown in exploration and development programs which resulted from the 1971 nationalization actions has been reversed. The Algerian state oil company, SONATRACH, contracted with nine foreign companies for exploration on more than 49,000 square miles of tracts covering both onshore and offshore areas.

Algerian production averaged 961,000 bpd in 1975; however, production plans call for an output of 1.3 million bpd by 1977 and 1.5 million bpd by 1980. Refining capacity in 1975 was reported at 120,000 bpd. Announced refinery expansion plans place capacity at 700,000 bpd by 1980. The largest refinery will be located at Skikda. It is scheduled for completion in 1979 at a 350,000-bpd-capacity. Algeria's petroleum product consumption projection for 1980 is less than 100,000 bpd affording 600,000 bpd of petroleum products for the export market.

China, People's Republic of.—Crude production approached an average of 1.6 million bpd in 1975, an increase of 20% over 1974 production. About 40% of China's total production is derived from the Taching field on the east coast. This field supplies most if not all of China's crude export, about 200,000 bpd in total, to markets in Japan, the Philippines, and Thailand; however, the wax content of Taching crude has decreased its marketability and future export patterns may be readjusted.

China's current refining capacity is estimated at over 1 million bpd. Refinery expansion programs balance proposed production programs which foresee output in a range of 2 to 2.4 million bpd by 1980.

Egypt.—Production increased by 57% to 231,000 bpd in 1975. Much of the production increase was attributed to the El Morgan field where a waterflood pressure maintenance project was underway, raising output from El Morgan to 80,000 bpd. Other significant producing fields include the July field, which yielded an average 35,000 bpd, and the Ramadan field which yielded an average of 25,000 bpd. At yearend 1975 the Sinai oilfields were returned to Egypt; the fields, which average 80,000 bpd, had been operated by Israel since the 1967 war. Production from the Sinai fields during Israeli occupation was estimated at well over 200 million barrels.

More than 30 companies have entered into exploration-production sharing contracts with the Egyptian General Petroleum Co. Several significant discoveries were reported in 1975, offering realistic support to the announced production goal of 1 million bpd by 1980.

Construction continued on the dual 42-inch pipeline connecting the Gulf of Suez to the Mediterranean Sea. Completion of the line was anticipated by 1976 at a cost of $400 million. Financing was shared by Egypt, Saudi Arabia, Kuwait, Qatar, and Abu Dhabi.

The Suez Canal was reopened in June. The draught of the canal is 38 feet placing severe limitations on use by laden tankers.

Indonesia.—The state petroleum and natural gas company, Pertamina, suffered serious liquidity problems in 1975, largely as a result of anticipating availability of long-term financing for approved projects when a recession economy offered only short-term financing. Revenues anticipated from petroleum exports were not realized and this further complicated Pertamina's credit status. In the face of reduced world demand, Indonesian production averaged 1.3 million bpd, well below its productive capacity of 1.7 million bpd. Higher premiums placed on Indonesian high-gravity, low sulfur crudes, and for proximity to Japanese ports had rendered Indonesian crude uncompetitive. With market realities in view, Indonesia adjusted crude oil prices in October far below the official 10% increase prescribed by OPEC. Minas crude was priced at $12.80 per barrel, representing an increase of only 1.6%. Furthermore, Indonesia reduced lesser quality crude prices by 4%, bringing Indonesian crudes more in line with Middle Eastern crudes delivered to markets in Japan.

The new pricing system resulted in increased production by November and December of an additional 50,000 bpd. Another measure to increase revenues was taken by raising the share of receipts from foreign companies on production-sharing contracts. Caltex, Indonesia's largest operator, producing over half the total crude output, agreed to cut profits and increase payments to the Government by $1.00 per barrel, adding $300 million to Indonesia's annual revenue. Readjustment of other production-sharing contracts was under consideration by yearend.

Iran.—Crude output was down by more than 11% from 1974 levels to an average of 5.3 million bpd as a result of reduced world demand. More than 91% of Iran's crude oil is produced from the Khuzestan oilfields onshore in southern Iran. Owned by the National Iranian Oil Co. and operated under a service contract by the Oil Service Co. of Iran, the Khuzestan Oil fields are under a production expansion program which includes an impressive gas injection program which should boost recovery of oil in place by 40% to 50% from a current rate of 20% to 30%. The project will utilize both associated and unassociated gas, requiring a total of 13 billion cubic feet per day. Productive capacity of the Khuzestan fields is close to 6 million bpd. The gas injection program will hopefully boost this capacity to 6.5 million bpd, a level which should be maintained for several years.

Iraq.—Crude production approached 2.3 million bpd, representing an increase of 15% over 1974 levels. A major factor in the increased production realized in 1975 was price readjustment.

The completion of a 412-mile, 42-inch pipeline between the Kirkuk and North Rumalia fields in 1975 was a most significant accomplishment for Iraq because it provided flexibility in marketing its crude via either Mediterranean or Persian Gulf ports. Formerly Kirkuk crude access to export markets was limited to a pipeline crossing Syria and Lebanon to reach Mediterranean terminals. The newly completed reverse-flow pipeline has an initial capacity of 500,000 bpd, and increases the pipelines' export capability. A 48-inch pipeline is under construction linking the North Rumalia field to Fao where submarine pipelines transport crude to a deep-water terminal about 26 miles out from the coast. The terminal is designed for two loading berths with capacity to load a total of 800,000 bpd. Eventual planned design could include six berths with a total loading capacity of 2.4 million bpd.

Libya.—Crude production averaged nearly 1.5 million bpd in 1975, a slight decrease from the 1974 level and a substantial decrease from the peak production level of 3.3 million bpd in 1970 before Government actions curtailed oil output.

The Libyan National Oil Corp. announced the discovery of a major offshore field in a concession operated by Elf-Aquitaine, but no further information was available at yearend. The Libyan National Oil Corp. also announced three discoveries in concession areas held by Occidental Petroleum Co. in the northwest Sirte basin area. Field development is linked with a production-sharing contract which affords Libya 81% of the production; the discovering company acquires 19%, free of taxes and royalty. Libya pays 81% of development costs; however, the payment is merely a loan which is to be repaid with interest over the field's productive period.

Nigeria.—Crude production was reduced by nearly 21% for an average of about 1.8 million bpd. The bulk of Nigeria's output is derived from Royal Dutch Shell and British Petroleum operations which yielded approximately 1.2 million bpd from 70 onshore oilfields.

Saudi Arabia.—Crude production capacity approaches 12 million bpd; however, production averaged about 7 million bpd owing to the reduction in world demand. More than half of Saudi's Arabia's production is derived from the Ghawar field, where production averaged 4.2 million bpd in 1975.

The Arabian American Oil Co. (Aramco) was the sole operator in Saudi Arabia. Government participation in Aramco was acquired in 1974 at 60%. Total Government ownership is anticipated by 1976 with Aramco providing operational personnel and technology.

Three new fields were discovered by Aramco in 1975. The offshore fields of Lawhah and Ribyan and the Dibdibah onshore field have augmented Saudi Arabian reserves by nearly 4.5 billion barrels.

U.S.S.R.—Production of crude oil and condensate averaged nearly 9.9 million bpd, an increase of 644,000 bpd over 1974 production levels. Most of the production increase was attributable to the Samotlar field in western Siberia where production averaged nearly 1.8 million bpd, as compared with more than 1.2 million bpd in 1974. The field's ultimate planned capacity of 2.4 million bpd should be reached by 1977. Production from other western Siberian fields averaged approximately 1.2

million bpd in 1975. Production from the Ural-Volga region was estimated at 3.5 million bpd. This region includes Tataria, where production was in excess of 2 million bpd. Other major producing areas in the region were Bashkiriya and Kuybyshev.

United Kingdom.—Production from the North Sea was realized in midyear when the Argyll field entered production. Production from the field averaged 35,000 bpd and was transported by tanker to the Isle of Grain refinery on the southwest coast of England. By October, the Forties field came onstream at 50,000 bpd. Production was delivered via pipeline to the Grangemouth refinery near Aberdeen, Scotland. Production from the Forties field is expected to reach 400,000 bpd by 1977, supplying approximately one-quarter of the United Kingdom's petroleum consumption requirements.

Venezuela.—Crude production dropped more than 21% below 1974 levels to 2.3 million bpd. Contributing factors to this decline were uncertainties associated with pending nationalization and Government-curtailed production. The bulk of Venezuela's output is derived from the Maracaibo onshore and offshore region. Other producing areas include Anzoátegui, Monagas, Guarico, and Barinas.

In 1975, Venezuela's exports of crude oil averaged nearly 1.5 million bpd and product exports averaged 0.6 million bpd, compared with 1.8 million bpd and 1.0 million bpd, respectively in 1974.

TECHNOLOGY

During 1975, new technology was developed for application in the exploration and drilling processes. Recent developments included (1) research on drill-bit design and deep-drilling effects, (2) mud system unitization and torque-reducing additives, (3) new tools for the control of blowouts and a system for detecting hydrocarbon and recovery of gas liquids, and (4) development of new offshore rig design and use of satellite communication systems.

The Division of Applied Technology of the Energy Research and Development Administration (ERDA) awarded the Sandia Laboratories of Albuquerque. N.M., $245,000 to study two drill-bit designs, which the laboratory proposed last year. The goal of this study is a design that will extend downhole life of the rotary bit before it must be pulled for replacement. If the extended-lift bit design is practical, appreciable savings in time needed for deep wells would make this type of bit worthwhile. The principle of the design is that a new cutting surface can be rotated into place when the cutting surface wears out, without pulling the drill string.[11]

Reed Tool Co. and Terra Tek, Inc., of Salt Lake City, have completed a full-scale installation capable of fully simulating downhole drilling conditions. The facility will mainly be used for testing full-scale rock bits at simulated depths of up to 30,000 feet and for research in geothermal and permafrost drilling.[12]

Houston Systems Manufacturing Co., custom-built a 600-barrel unitized mud system for use in Saudi Arabia. This system is trailer-mounted on retractable 10-foot tires, measures 73 by 23 feet, and rests flat on the ground on location. It has its own mud-mixing equipment, shale shaker, mud agitators, desanders, degassers, and disilters.[13]

DSC, Inc., of Richardson, Tex., has developed a drilling-soap concentrate that disperses rather than dissolve in the drilling fluid. It is claimed to be capable of reducing inhole torque by 50% after the initial circulation of the product. This soap concentrate, which is tradenamed Torkeuse, decreases the effects of hole drag, torque, and differential sticking; by improving pump efficiency and by increasing depth of the clear water drilling phase, costs are reduced. Most drilling-mud detergents are solutions of water-soluble soaps. The new additive is a concentrated suspension of complex soap which are only soluble in fresh water and practically insoluble in saturated salt water, making the additive disperse rather than dissolve.[14]

Hydril has developed a pump down type blowout preventer that provides complete

[11] World Oil. Drill Bit Research. V. 180, No. 5, April 1975, p. 15.
[12] World Oil. Drilling Research Lab. V. 180, No. 1, January 1975, p. 13.
[13] World Oil. Unitized Mud System. V. 181, No. 6. November 1975, p. 17.
[14] World Oil. Torque Reducing Additive. V. 180, No. 5, April 1975, p. 5.

closure inside the drill pipe when a blowout is imminent. The drop-in check valve is kept on the surface until needed and thus is not subject to downhole wear. The valve can be pumped or is allowed to float down the drill pipe to a special landing sub just above the drill collars. Once the valve is seated, it provides automatic check valve capabilities and downward circulation can be accomplished.

During normal drilling operations, the only device downhole is a landing sub containing a stop ring. There is a slight restriction in the sub, but there is no interference with normal drilling operations, wireline operations, surveying, or other functions. The valve is removed by pulling the drill string and unscrewing the stop ring.[15]

Texaco Inc. has developed and is using a carbon/oxygen logging system that gives a direct indication of the oil zone and is independent of salinity and shaliness. The difficulty of using conventional radioactivity or electric logs to evaluate oil zones in low-salinity formations can now be solved with the carbon/oxygen logging system. The carbon/oxygen ratio increases in the oil zones compared with the water zones because of the combined increase in fluid carbon content and decrease in oxygen content. A similar increase in carbon/oxygen ratio is observed when changing from a sandstone to a limestone because of the difference in carbon and oxygen contents of the matrices. This matrix effect can be removed by using a calcium-to-silicon ratio that is measured simultaneously with a carbon/oxygen ratio.[16]

Warren Petroleum Co., a Division of Gulf Oil Co., has developed a gas liquids extraction plant which is highly portable. It is basically a rich gas process which can recover 65% to 75% propane and essentially all the heavier components from a small volume of rich gas (10 million standard cubic feet down to 100,000 standard cubic feet).

There has been little incentive to process small lean gas volumes because the amount of liquids involved is inadequate to support any substantial capital investment. This portable plant may fill the need for a rich gas process for small volumes. When gas volumes are larger, the process is modified to recover ethane and heavier components from lean gas. The plant is capable of unattended operations, and malfunction shutdown controls with telltale panel are incorporated in the design. Hydrates are controlled by methanol injection.[17]

Cities Service Co. is the world's first energy company to be approved by the Federal Communications Commission for offshore telecommunication service on Westar I, the first commercial domestic communications satellite. Under the program, using Western Union's satellite system, Cities Service will be able to use 12-voice-frequency channels providing voice, data, and facsimile capabilities for communication with their offshore work crews for a 2-year contract. Delivery is set for mid-September 1976.[18]

Pat Rutherford, Sr., a large semisubmersible drilling unit capable of drilling to 20,000 feet in 600 feet of water, will go to Texaco Trinidad, Inc.

Bethlehem Steel Corp., Beaumont, Tex., is building a jack-up rig with telescoping legs. This rig, J Storm VII, a new design, permits the mat-supported vessel to be operated in water depths of up to 375 feet. The rig is to be delivered to Southern Marine Drilling Co. under contract to Atlantic Richfield.

Further technical improvements are needed to accelerate petroleum production and increase proven reserves. Fieldwork and backup laboratory research are being performed by the U.S. Department of the Interior and private industries with grants to universities. It is hoped that new ideas and improvement in present technology will be beneficial in the quest for energy independence.

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[15] World Oil. Downhole Blowout Prevented. V. 181, No. 2, August 1975, p. 13.

[16] Petroleum Engineer International. New Logging System for Detecting Hydrocarbons. V. 47, No. 7, July 1975, p. 25.

[17] Petroleum Engineer International. Innovation in Gas Liquids Recovery. V. 47, No. 9, August 1975, p. 17.

[18] World Oil. Satellite Communication System. V. 180, No. 6, May 1975, p. 15.

Table 2.—Supply, demand, and stocks of

(Thousand

	Jan.	Feb.	Mar.	Apr.	May
1974					
New supply:					
Domestic production:					
Crude oil	263,727	244,169	265,163	256,234	263,749
Lease condensate	13,223	11,813	12,764	12,385	12,479
Natural gas plant liquids	52,672	48,392	53,983	50,872	52,379
Imports: [1]					
Crude oil	73,839	62,940	76,329	98,011	121,139
Unfinished oils	3,632	3,315	5,063	6,443	6,564
Plant condensate	3,054	3,433	3,238	3,050	2,000
Refined products	85,967	76,361	78,858	71,885	71,591
Other hydrocarbons and hydrogen refinery input	977	1,123	751	1,200	1,174
Total new supply	497,091	451,546	496,149	500,080	531,075
Crude oil unaccounted for [2]	−2,532	+714	+2,484	+607	−918
Processing gain	14,853	12,109	12,952	14,344	12,843
Total supply	509,412	464,369	511,585	515,031	543,000
Change in stocks, all oils [3]	−33,244	−27,892	+5,924	+29,491	+47,449
Total disposition of primary supply	542,656	492,261	505,661	485,540	495,551
Exports: [4]					
Crude oil	534	281	--	15	200
Refined products	5,874	5,399	6,064	7,285	7,443
Crude losses	386	341	382	385	412
Domestic demand for products:					
Gasoline:					
Motor gasoline	179,935	170,797	191,020	193,708	209,107
Aviation gasoline	1,265	870	1,655	1,276	1,325
Total gasoline	181,200	171,667	192,675	194,984	210,432
Jet fuel:					
Naphtha-type	5,365	4,637	6,306	6,527	8,399
Kerosine-type	22,385	19,442	23,320	21,689	24,248
Total jet fuel	27,750	24,079	29,626	28,216	32,647
Ethane (including ethylene)	10,405	9,983	11,417	10,073	9,881
Liquefied gases:					
LRG [5] for fuel use	7,052	6,403	6,679	7,004	7,018
LRG [5] for chemical use	3,036	2,802	3,279	2,993	2,553
LPG [6] for fuel and chemical use	34,268	25,020	21,852	18,904	16,432
Total liquefied gases	44,356	34,225	31,810	28,901	26,003
Kerosine	9,657	7,866	5,518	3,899	2,210
Distillate fuel oil	118,898	107,765	98,088	85,566	75,949
Residual fuel oil	94,102	83,755	79,229	73,111	70,057
Petrochemical feedstocks: [7]					
Still gas	1,263	877	799	795	889
Naphtha–400°	4,825	4,957	4,911	4,164	5,089
Other	4,674	4,152	4,237	4,023	3,705
Total petrochemical feedstocks	10,762	9,986	9,947	8,982	9,683
Special naphthas	2,667	2,668	2,730	3,014	2,881
Lubricants	5,230	4,360	4,915	4,697	5,211
Wax	695	513	624	556	600
Coke	7,789	6,969	8,164	7,033	6,594
Asphalt	6,873	7,637	9,298	12,074	16,911
Road oil	115	137	156	342	479
Still gas	13,833	12,543	13,285	14,472	14,835
Miscellaneous products	1,530	1,333	1,302	1,272	2,421
Plant condensate	--	[8] 754	431	663	702
Total domestic demand	535,862	486,240	499,215	477,855	487,496
Stocks all oils:					
Crude oil and lease condensate	233,035	240,723	244,665	256,385	269,455
Unfinished oils	97,862	95,077	106,861	109,501	116,748
Natural gasoline [9]	6,428	6,705	6,542	7,096	7,445
Plant condensate	1,608	1,445	1,770	1,330	1,097
Refined products	636,130	603,221	593,257	608,274	635,290
Total	975,063	947,171	953,095	982,586	1,030,035

See footnotes at end of table.

all oils in the United States, by month
barrels)

June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
251,744	260,270	257,757	241,917	254,933	244,789	252,484	3,056,936
11,663	11,914	11,908	11,371	12,016	12,275	11,838	145,649
50,514	51,354	51,942	49,144	52,268	50,817	51,761	616,098
117,747	126,835	121,634	113,907	118,096	118,739	119,939	1,269,155
3,634	3,805	3,799	1,456	2,300	1,977	2,240	44,228
2,387	2,427	2,488	2,693	2,825	2,718	2,051	32,364
67,031	69,565	69,276	63,498	68,209	80,518	82,441	885,200
1,203	1,246	1,505	1,005	903	994	976	13,057
505,923	527,416	520,309	484,991	511,550	512,827	523,730	6,062,687
−33	−1,109	−2,324	−784	−597	−3,148	−1,444	−9,084
15.349	16,030	16,656	14,901	16,703	14,517	13,998	175,255
521,239	542,337	534,641	499,108	527,656	524,196	536,284	6,228,858
+30.162	+27,250	+13,514	+12,874	−8,153	−2,336	−29,700	+65,339
491,077	515,087	521,127	486,234	535,809	526,532	565,984	6,163,519
44	--	--	--	--	--	--	1,074
7,108	7,849	7,664	5,126	6,847	5,594	7,164	79,417
411	427	422	394	411	400	418	4,789
207,577	215,732	218,904	191,628	208,078	196,396	203,295	2,386,177
1,511	1,373	1,835	1,341	1,595	1,172	997	16,215
209,088	217,105	220,739	192,969	209,673	197,568	204,292	2,402,392
7,262	6,627	7,404	7,891	7,089	7,202	6,462	81,171
21,289	25,244	24,557	25.389	24,257	23,752	25.857	281,429
28,551	31,871	31,961	33,280	31,346	30,954	32,319	362,600
9,649	10,041	10,255	9,855	11,020	10,954	11,049	124,582
6,653	7,725	7,103	7,564	6,821	6,730	6,455	83,207
3,135	3,094	3,425	3,300	3,198	2,547	2,213	35,575
17,615	15,277	16,447	19,510	24,699	27,387	32,310	269,721
27,403	26,096	26,975	30,374	34,718	36,664	40,978	388,503
3,442	3,864	4,360	4,136	5,964	5,866	7,570	64,352
71,311	71,566	71,575	71,561	89,496	94,699	119,442	1,075,916
72,147	76,665	78,407	74,250	80,948	88,061	92,484	963,216
1,232	1,184	1,308	1,298	1,464	1,246	2,020	14,375
5,162	5,915	6,178	5,369	5,367	5,137	4,805	61,879
4,026	5,383	5,029	5,039	5,163	5,730	5,053	56,214
10,420	12,482	12,515	11,706	11,994	12,113	11,878	132,468
2,451	2,817	2,820	2,602	2,843	2,391	2,092	31,976
4,093	4,997	4,515	4,869	5,013	4,355	4,415	56,670
591	624	623	513	561	508	393	6,801
7,119	7,040	7,192	7,760	6,605	7,118	7,673	87,056
18,111	20,059	20,378	19,213	19,381	12,064	6,734	168,733
948	1,198	1,109	953	949	407	88	6,881
15,616	16,869	16,545	14,220	14,981	14,217	14,308	175,724
2,354	2,865	2,454	1,891	2,509	2,084	2,248	24,263
220	652	618	562	550	515	439	6,106
483,514	506,811	513,041	480.714	528,551	520.538	558,402	6,078,239
268,765	268,686	264,840	266,726	269,437	271,144	265,020	265,020
118,720	116,727	113,223	109,554	110,002	109,136	106,031	106,031
7,908	7,784	7,888	7,955	7,232	6,860	6,480	6,480
1,216	1,049	1,062	1,120	1,167	1,243	1,070	1,070
663,588	693,201	713,948	728.480	717,844	714,963	695,045	695,045
1,060.197	1,087,447	1,100.961	1,113,835	1,105,682	1,103,346	1,073,646	1,073,646

Table 2.—Supply, demand, and stocks of

(Thousand

	Jan.	Feb.	Mar.	Apr.	May
1975 p					
New supply:					
Domestic production:					
Crude oil	250,526	229,936	251,667	242,363	248,419
Lease condensate	11,578	10,616	11,630	11,335	11,323
Natural gas plant liquids	50,515	46,086	51,396	49,056	49,818
Imports: [1]					
Crude oil	124,901	107,194	113,345	101,338	108,072
Unfinished oils	921	1,323	1,330	817	841
Plant condensate	2,430	1,836	2,544	2,231	1,828
Refined products	83,783	62,578	60,420	46,605	49,730
Other hydrocarbons and hydrogen refinery input	946	850	775	1,110	1,128
Total new supply	525,600	460,419	493,107	454,855	471,159
Crude oil unaccounted for [2]	+1,301	+55	−3,214	+1,840	+3,633
Processing gain	16,084	12,272	13,043	11,434	12,768
Total supply	542,985	472,746	502,936	468,129	487,560
Change in stocks, all oils [3]	−21,972	−12,930	−9,854	−19,199	+12,235
Total disposition of primary supply	564,957	485,676	512,790	487,328	475,325
Exports: [4]					
Crude oil	836	942	349	19	--
Refined products	6,234	6,002	6,257	5,694	6,275
Crude losses	411	370	399	384	401
Domestic demand for products:					
Gasoline:					
Motor gasoline	192,382	170,691	196,097	201,542	213,010
Aviation gasoline	978	1,046	1,037	1,176	1,116
Total gasoline	193,360	171,737	197,134	202,718	214,126
Jet fuel:					
Naphtha-type	5,282	5,768	6,364	5,758	6,678
Kerosine-type	26,994	24,320	24,080	24,424	23,623
Total jet fuel	32,276	30,088	30,444	30,182	30,301
Ethane (including ethylene)	10,909	9,483	10,305	9,957	10,056
Liquefied gases:					
LRG [5] for fuel use	7,747	6,151	6,282	6,157	5,686
LRG [5] for chemical use	1,993	1,857	2,176	1,785	2,042
LPG [6] for fuel and chemical use	31,864	24,441	24,274	18,928	12,941
Total liquefied gases	41,604	32,449	32,732	26,870	20,669
Kerosine	6,814	7,078	5,182	4,384	3,017
Distillate fuel oil	122,534	106,490	102,075	92,812	73,852
Residual fuel oil	100,514	79,762	82,704	66,756	63,526
Petrochemical feedstocks: [7]					
Still gas	1,313	1,145	1,077	1,155	1,070
Naphtha-400°	4,613	3,517	4,214	3,586	3,961
Other	5,033	2,935	3,732	2,517	3,122
Total petrochemical feedstocks	10,959	7,597	9,023	7,258	8,153
Special naphthas	2,141	2,099	1,786	2,296	2,361
Lubricants	4,533	3,187	3,250	4,309	4,210
Wax	590	404	348	498	392
Coke	7,645	6,958	6,900	7,210	6,723
Asphalt	5,596	5,267	6,100	9,141	12,730
Road oil	236	50	98	190	414
Still gas	14,798	12,919	14,312	13,674	14,822
Miscellaneous products	2,526	2,397	2,893	2,551	2,956
Plant condensate	441	397	499	425	341
Total domestic demand	557,476	478,362	505,785	481,231	468,649
Stocks all oils:					
Crude oil and lease condensate	270,462	276,755	279,989	281,908	280,961
Unfinished oils	97,488	99,182	103,345	107,071	113,922
Natural gasoline [9]	6,684	6,330	5,996	5,938	6,105
Plant condensate	1,115	1,271	1,115	1,057	1,159
Refined products	723,395	702,676	685,915	661,187	667,249
Total	1,099,144	1,086,214	1,076,360	1,057,161	1,069,396

p Preliminary (except for crude oil and lease condensate production).
[1] U.S. Department of the Interior data for crude oil, unfinished oils, and plant condensate; U.S.
of crude oil include some Athabasca hydrocarbons.
[2] Represents the difference between supply and indicated demand for crude oil.
[3] Minus represents withdrawal from stock, which is added to total disposition; plus represents
[4] U.S. Department of Commerce data.
[5] Liquefied refinery gas.
[6] Liquefied petroleum gas.
[7] Produced at petroleum refineries. Demand data for ethane and liquefied gases used for petro-
are included under items "Ethane" and "Liquefied gases."
[8] Includes January data of 372,000 barrels.
[9] Includes isopentane.

all oils in the United States, by month—Continued

barrels)

June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
241,738	247,193	244,241	237,821	246,715	237,822	244,213	2,922,654
10,886	11,215	11,471	10,568	11,342	10,514	11,647	134,125
49,390	50,260	51,143	47,302	50,922	49,048	51,022	595,958
117,142	129,966	142,016	140,675	136,068	138,703	138,761	1,498,181
1,291	1,354	1,066	816	1,212	836	1,178	12,985
2,212	2,311	2,514	2,646	1,842	1,971	2,607	26,972
41,568	51,780	48,437	60,012	56,074	49,364	50,507	660,858
1,214	1,498	1,326	1,116	1,303	1,349	1,164	13,779
465,441	495,577	502,214	500,956	505,478	489,607	501,099	5,865,512
−1,196	+1,063	+44	+3,259	+280	−3,918	+2,901	+6,048
12,970	13,365	13,812	15,841	15,905	14,839	15,449	167,782
477,215	510,005	516,070	520,056	521,663	500,528	519,449	6,039,342
+1,754	+15,200	+20,565	+40,423	+8,787	+23,520	−46,690	+11,839
475,461	494,805	495,505	479,633	512,876	477,008	566,139	6,027,503
--	--	--	--	--	--	--	2,146
6,733	5,756	6,289	6,159	5,796	4,977	8,110	74,282
403	430	434	418	413	410	426	4,899
212,285	218,258	217,257	201,861	210,107	191,690	211,049	2,436,229
1,213	1,443	1,350	1,365	1,349	1,071	923	14,067
213,498	219,701	218,607	203,226	211,456	192,761	211,972	2,450,296
5,782	5,985	6,597	7,012	6,833	7,097	7,387	76,543
23,899	23,586	25,843	24,179	24,066	22,875	20,858	288,747
29,681	29,571	32,440	31,191	30,899	29,972	28,245	365,290
9,137	10,315	10,599	10,604	11,413	10,630	11,140	124,548
5,509	6,890	6,710	6,811	6,680	6,134	7,402	78,159
2,814	2,818	2,888	2,811	2,470	2,515	2,561	28,730
12,262	16,495	[illegible]	17,116	23,295	23,220	33,176	255,008
20,585	26,203	[illegible]	26,738	32,445	31,869	43,139	361,897
3,961	3,022	[illegible]	3,750	4,528	4,403	8,534	57,990
67,990	65,466	[illegible]	64,882	82,937	76,308	117,130	1,039,841
65,367	69,421	65,647	69,880	69,365	70,466	84,555	887,963
1,298	1,379	1,430	1,309	1,482	1,704	1,361	15,723
4,272	4,518	4,557	5,041	5,053	5,164	5,016	53,512
3,895	4,283	4,507	3,975	4,592	4,212	4,735	47,538
9,465	10,180	10,494	10,325	11,127	11,080	11,112	116,773
2,103	2,808	2,157	2,335	2,419	2,426	2,559	27,490
4,473	4,243	4,609	4,443	4,858	3,704	4,350	50,169
421	524	529	596	695	568	511	6,076
6,963	8,409	7,810	7,532	8,519	7,531	7,848	90,048
17,127	18,274	19,096	18,924	17,734	11,479	5,916	147,384
694	1,640	664	416	312	476	263	5,453
14,536	16,264	15,743	14,871	14,273	13,860	15,279	175,351
2,115	2,186	2,252	2,348	3,237	3,270	3,943	32,674
209	392	859	995	450	818	1,107	6,933
468,325	488,619	488,782	473,056	506,667	471,621	557,603	5,946,176
276,132	264,157	256,616	259,446	269,584	270,950	271,354	271,354
[illegible]	108,580	110,759	107,374	106,327	108,767	106,352	106,352
[illegible]	6,577	6,373	6,247	[illegible]	5,954	6,217	6,217
1,337	1,117	978	979	[illegible]	892	1,165	1,165
675,080	705,919	732,189	773,292	[illegible]	793,082	747,867	747,867
1,071,150	1,086,350	1,106,915	1,147,338	1,156,125	1,179,645	1,132,955	1,132,955

Department of Commerce and Federal Energy Administration data for all other imports. Imports

stocks increase, which is subtracted from total disposition.

chemical feedstocks are excluded. Demand data for these products for petrochemical feedstocks used

Table 3.—Supply, demand, and stocks of all oils in 1975, by PAD district

(Thousand barrels)

	PAD district						Total United States
	I	II	III	IV	Total I–IV	V	
Domestic production:							
Crude oil and lease condensate	48,498	322,265	2,044,056	249,177	2,663,996	392,783	3,056,779
Natural gas plant liquids	12,977	86,294	467,878	18,715	585,864	10,094	595,958
Receipts from other districts	1,138,910	946,654	77,700	24,182	8,462	65,479	--
Imports:							
Plant condensate	2,959	15,101	--	6,594	24,654	2,318	26,972
Crude oil	451,549	282,658	437,049	16,090	1,187,346	310,835	1,498,181
Unfinished oils	6,038	392	4,170	--	10,600	2,385	12,985
Refined products	566,341	33,973	15,989	5,733	622,036	38,822	660,858
Other hydrocarbons and hydrogen refinery input	994	992	7,595	366	9,947	3,832	13,779
Total new supply	2,228,266	1,688,329	3,054,437	320,857	5,112,905	826,548	5,865,512
Crude oil unaccounted for	+408	+26,673	−14,786	+428	+12,723	−6,675	+6,048
Processing gain	22,304	50,079	61,191	3,737	137,311	30,471	167,782
Total supply	2,250,978	1,765,081	3,100,842	325,022	5,262,939	850,344	6,039,342
Change in stocks, all oils [2]	−12,989	+10,863	+8,753	−145	+6,482	+5,357	+11,839
Total disposition of primary supply	2,263,967	1,754,218	3,092,089	325,167	5,256,457	844,987	6,027,503
Exports:							
Crude oil	--	--	2,127	19	2,146	--	2,146
Refined products	5,310	4,256	35,423	39	45,028	29,254	74,282
Shipments to other districts	100,722	85,731	1,090,745	148,265	65,479	8,462	--
Crude oil losses (estimated for individual districts I–IV)	610	1,225	2,634	57	4,526	373	4,899
Domestic demand for products:							
Gasoline:							
Motor gasoline	808,049	833,642	361,619	77,665	2,080,975	355,254	2,436,229
Aviation gasoline	3,210	3,570	3,287	599	10,666	3,401	14,067
Total gasoline	811,259	837,212	364,906	78,264	2,091,641	358,655	2,450,296
Jet fuel:							
Naphtha-type	21,825	14,308	15,122	3,072	54,327	22,216	76,543
Kerosine-type	115,652	54,250	27,444	7,813	205,159	83,588	288,747
Total jet fuel	137,477	68,558	42,566	10,885	259,486	105,804	365,290
Ethane (including ethylene)	3,866	15,213	103,867	1,262	124,208	340	124,548
Liquefied gases	65,766	131,983	134,623	11,402	343,774	18,123	361,897
Kerosine	24,644	16,195	13,263	884	54,986	3,004	57,990
Distillate fuel oil	463,700	318,530	121,549	39,954	943,733	96,108	1,039,841
Residual fuel oil	532,572	95,176	103,075	13,198	744,021	143,942	887,963
Petrochemical feedstocks	10,683	7,818	93,611	918	113,030	3,743	116,773
Special naphthas	7,303	8,628	7,606	68	23,605	3,885	27,490
Lubricants	19,807	11,593	13,043	546	44,989	5,180	50,169

Wax	1,718	1,421	2,191	113	5,443	633	6,076
Coke	11,029	35,013	27,134	3,771	76,947	13,101	90,048
Asphalt	37,079	51,955	28,671	10,128	127,833	19,551	147,384
Road oil	9	2,877	463	371	3,720	1,733	5,453
Still gas for fuel	20,297	47,418	71,547	4,931	144,193	31,158	175,351
Miscellaneous products	10,116	6,483	14,045	92	30,736	1,938	32,674
Plant condensate	--	6.933	--	--	6,933	--	6,933
Total domestic demand	2,157,325	1,663,006	1,142,160	176,787	5,139,278	806,898	5,946,176
Stocks of all oils:							
Crude oil and lease condensate	15,871	83,044	112,857	16,649	228,421	42,933	271,354
Unfinished oils	12,046	23,757	40,050	2,441	78,294	28,058	106,352
Natural gasoline and isopentane [2]	28	1,539	4,524	65	6,156	61	6,217
Plant condensate	73	183	745	145	1,146	19	1,165
Refined products	220,903	214,257	222,445	17,404	675,009	72,858	747,867
Total	248,921	322,780	380,621	36,704	989,026	143,929	1,132,955

[1] Minus represents withdrawal from stocks, which is added to total disposition; plus represents stocks increase, which is subtracted from total disposition.
[2] Excludes imports for synthetic natural gas (SNG) plant feedstock use.

Table 4.—Supply, demand, and stocks of all oils in the United States

(Thousand barrels)

Item	1971	1972	1973	1974	1975 p
Domestic production:					
Crude oil	3,296,612	3,293,399	3,206,012	3,056,936	2,922,654
Lease condensate	157,302	161,969	154,891	145,649	134,125
Natural gas plant liquids	617,815	638,216	634,423	616,098	595,958
Imports:[1]					
Crude oil	613,417	811,135	1,183,996	1,269,155	1,498,181
Unfinished oils	45,193	45,705	50,161	44,228	12,985
Plant condensate	13,321	31,428	39,344	32,364	26,972
Refined products	760,949	847,046	1,009,992	885,200	660,858
Other hydrocarbons and hydrogen refinery input	6,074	10,118	10,716	13,057	13,779
Total new supply	5,510,683	5,839,016	6,289,535	6,062,687	5,865,512
Crude oil unaccounted for[2]	+14,823	+10,201	+918	−9,084	+6,048
Processing gain	139,433	142,161	165,488	175,255	167,782
Total supply	5,664,939	5,991,378	6,455,941	6,228,858	6,039,342
Change in stocks, of all oils	+26,086	−84,968	+49,328	+65,339	+11,839
Total disposition of primary supply	5,638,853	6,076,346	6,406,613	6,163,519	6,027,503
Exports:[3]					
Crude oil	503	187	697	1,074	2,146
Refined products	81,342	81,202	83,716	79,417	74,282
Crude losses	4,448	4,641	4,897	4,789	4,899
Domestic demand for products:					
Gasoline:					
Motor gasoline	2,195,267	2,333,778	2,436,156	2,386,177	2,436,229
Aviation gasoline	17,892	16,925	16,531	16,215	14,067
Total gasoline	2,213,159	2,350,703	2,452,687	2,402,392	2,450,296
Jet fuel:					
Naphtha-type	94,732	88,495	79,220	81,171	76,543
Kerosine-type	273,991	293,995	307,407	281,429	288,747
Total jet fuel	368,723	382,490	386,627	362,600	365,290
Ethane (including ethylene)	87,744	106,201	119,443	124,582	124,548
Liquefied gases	369,008	413,649	409,318	388,503	361,897
Kerosine	90,917	85,852	78,915	64,352	57,990
Distillate fuel oil	971,316	1,066,110	1,128,714	1,075,916	1,039,841
Residual fuel oil	838,045	925,647	1,030,177	963,216	887,963
Petrochemical feedstocks[4]	110,525	123,697	129,929	132,468	116,773
Special naphthas	29,762	31,866	32,230	31,976	27,490
Lubricants	49,321	52,813	59,171	56,670	50,169
Wax	5,248	5,409	6,941	6,801	6,076
Coke	79,897	88,276	95,156	87,056	90,048
Asphalt	158,526	163,788	182,602	168,733	147,384
Road oil	8,487	7,538	7,832	6,881	5,453
Still gas for fuel	156,967	170,993	176,758	175,724	175,351
Miscellaneous products	14,915	15,284	18,934	24,263	32,674
Plant condensate	--	--	1,869	6,106	6,933
Total domestic demand	5,552,560	5,990,316	6,317,303	6,078,239	5,946,176
Stocks of all oils:					
Crude oil and lease condensate	259,648	246,395	242,478	265,020	271,354
Unfinished oils	100,574	94,761	99,154	106,031	106,352
Natural gasoline[5]	5,163	4,802	6,160	6,480	6,217
Plant condensate	1,013	1,273	1,675	1,070	1,165
Refined products	677,549	611,748	658,840	695,045	747,867
Total	1,043,947	958,979	1,008,307	1,073,646	1,132,955

p Preliminary (except for crude oil and lease condensate production).
[1] U.S. Department of the Interior data for crude oil, unfinished oils, and plant condensate; U.S. Department of Commerce and Federal Energy Administration data for all other imports. Imports of crude oil include some Athabasca hydrocarbons.
[2] Represents the difference between supply and indicated demand for crude petroleum.
[3] U.S. Department of Commerce data.
[4] Produced at petroleum refineries. Demands for ethane and liquefied gases used for petrochemical feedstocks are excluded. Demand data for these products for petrochemical feedstocks used are included under the items "Ethane" and "Liquefied Gases."
[5] Includes isopentane.

Table 5.—Supply and disposition of crude petroleum (including lease condensate) in the United States

(Thousand barrels)

Supply and disposition	1971	1972	1973	1974	1975
Supply:					
Production	3,453,914	3,455,368	3,360,903	3,202,585	3,056,779
Imports [1]	613,417	811,135	1,183,996	1,269,155	1,498,181
Total new supply	4,067,331	4,266,503	4,544,899	4,471,740	4,554,960
Stock changes: [2]					
Domestic crude oil	−23,239	−17,064	−9,964	+13,758	+2,849
Foreign crude oil	+6,520	+3,811	+6,047	+8,784	+3,485
Crude oil unaccounted for [3]	+14,823	+10,201	+918	−9,084	+6,048
Disposition by use:					
Runs of domestic crude oil	3,481,543	3,473,880	3,359,946	3,168,596	3,047,014
Runs of foreign crude oil	606,266	806,983	1,177,308	1,260,130	1,494,412
Exports [4]	503	187	697	1,074	2,146
Transfers:					
Distillate fuel oil	1,548	944	760	774	587
Residual fuel oil	4,565	3,322	6,126	4,751	5,616
Losses	4,448	4,641	4,897	4,789	4,899
Total disposition by use	4,098,873	4,289,957	4,549,734	4,440,114	4,554,674

[1] Bureau of Mines data.
[2] Minus represents withdrawal from stock; plus represents stock increase.
[3] Represents the difference between supply and indicated demand for crude petroleum.
[4] U.S. Department of Commerce data.

Table 6.—Production of crude petroleum (including lease

(Thousand

State	Jan.	Feb.	Mar.	Apr.	May
1974					
Alabama	1,014	888	1,015	953	1,005
Alaska	5,932	5,323	5,686	5,402	5,925
Arizona	56	54	67	62	67
Arkansas	1,383	1,333	1,492	1,447	1,458
California:					
South	10,841	9,846	10,890	10,362	10,722
Central Coastal	6,434	5,862	6,458	6,258	6,388
East Central	10,681	9,616	10,320	9,935	10,266
North	55	46	47	45	43
Total California	28,011	25,370	27,715	26,600	27,419
Colorado	3,103	2,923	3,156	3,221	3,083
Florida	2,838	2,712	2,891	3,085	3,317
Illinois	2,344	2,188	2,351	2,395	2,407
Indiana	424	390	409	420	430
Kansas	5,127	4,947	5,339	5,304	5,400
Kentucky	675	640	687	667	714
Louisiana:					
Gulf Coast	64,347	57,942	62,898	60,292	61,220
Rest of State	3,314	2,935	3,167	3,169	3,287
Total Louisiana	67,661	60,877	66,065	63,461	64,507
Michigan	1,365	1,210	1,355	1,422	1,479
Mississippi	4,608	3,916	4,412	4,253	4,362
Missouri	5	4	5	4	5
Montana	2,910	2,669	3,031	2,992	3,012
Nebraska	540	520	577	555	564
Nevada	9	8	8	6	9
New Mexico:					
Southeastern	6,777	7,152	7,943	7,549	7,853
Northwestern	635	603	686	677	686
Total New Mexico	7,412	7,755	8,629	8,226	8,539
New York	77	71	68	80	77
North Dakota	1,642	1,500	1,695	1,643	1,659
Ohio	675	673	727	750	844
Oklahoma	14,807	15,459	15,454	13,981	15,308
Pennsylvania	297	262	282	286	309
South Dakota	39	38	41	38	41
Tennessee	64	64	64	64	64
Texas:					
District 01	1,690	1,536	1,718	1,603	1,647
District 02	6,278	5,589	6,198	5,943	6,199
District 03	14,054	13,521	14,976	14,777	15,179
District 04	4,744	4,254	4,586	4,403	4,412
District 05	1,822	1,642	1,809	1,749	1,801
District 06, except East Texas	7,458	6,698	7,417	7,110	7,253
East Texas	6,257	5,664	6,244	6,054	6,218
District 07B	3,065	2,841	3,131	3,064	3,140
District 07C	2,852	2,557	2,818	2,646	2,671
District 08	23,845	21,613	23,859	22,922	23,585
District 08A	30,522	27,721	30,765	29,563	30,348
District 09	3,720	3,416	3,717	3,560	3,632
District 10	1,798	1,687	1,860	1,832	1,857
Total Texas	108,105	98,739	109,098	105,226	107,942
Utah	3,030	3,249	3,455	3,290	3,288
Virginia	1	--	--	--	1
West Virginia	206	221	206	334	223
Wyoming	12,590	11,979	11,947	12,452	12,770
Total United States:					
1974	276,950	255,982	277,927	268,619	276,228
1973	284,454	263,066	287,430	278,757	287,134
Daily average, 1974	8,934	9,142	8,965	8,954	8,911
Pennsylvania grade (included in U.S. total)	1,104	1,069	1,120	1,253	1,171
1975					
Alabama	1,172	965	1,140	1,082	1,141
Alaska	5,992	5,372	5,879	5,652	5,948
Arizona	63	51	57	54	54
Arkansas	1,308	1,239	1,263	1,319	1,364
California:					
South	10,602	9,580	10,550	10,157	10,506
Central Coastal	6,283	5,607	6,199	6,046	6,245
East Central	10,315	9,391	10,420	10,326	10,706

See source notes at end of table.

condensate) in the United States, by State and month

barrels)

June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1,002	1,203	1,265	1,228	1,258	1,204	1,288	13,323
6,048	6,273	6,203	5,894	6,101	5,881	5,935	70,603
63	63	66	63	60	59	60	740
1,363	1,455	1,303	1,242	1,318	1,333	1,400	16,527
10,064	10,579	10,692	10,293	10,600	10,282	10,512	125,683
6,221	6,408	6,410	6,189	6,415	6,214	6,346	75,603
9,967	10,143	10,234	9,806	10,148	9,922	10,133	121,171
41	45	43	44	47	45	45	546
26,293	27,175	27,379	26,332	27,210	26,463	27,036	323,003
3,089	3,155	3,266	3,062	3,177	3,177	3,096	37,508
3,126	3,087	3,096	2,998	3,105	3,011	3,085	36,351
2,208	2,370	2,290	2,229	2,354	2,171	2,246	27,553
376	441	417	397	428	395	392	4,919
5,063	5,302	5,182	4,987	5,185	4,859	4,996	61,691
635	672	710	631	655	560	591	7,837
57,748	59,851	59,385	48,943	56,993	54,273	54,596	698,488
3,280	3,338	3,392	3,195	3,337	3,193	3,229	38,836
61,028	63,189	62,777	52,138	60,330	57,466	57,825	737,324
1,440	1,521	1,629	1,602	1,713	1,623	1,662	18,021
4,198	4,313	4,248	4,065	4,233	4,067	4,104	50,779
4	5	5	4	5	5	5	56
2,842	2,858	2,885	2,853	2,914	2,741	2,847	34,554
541	570	569	547	559	537	532	6,611
18	14	13	10	12	11	11	129
7,497	7,630	7,591	7,594	7,786	7,554	7,769	90,695
665	703	689	670	673	658	655	8,000
8,162	8,333	8,280	8,264	8,459	8,212	8,424	98,695
73	76	77	76	78	73	70	896
1,629	1,669	1,682	1,630	1,673	1,619	1,656	19,697
749	848	742	715	795	789	781	9,088
14,755	15,295	14,324	14,577	14,818	14,016	15,491	177,785
292	327	311	277	296	268	271	3,478
34	40	42	44	47	45	45	494
64	64	64	64	64	64	65	769
1,565	1,618	1,585	1,511	1,568	1,527	1,570	19,138
5,903	6,007	6,065	5,745	5,971	5,774	5,918	71,590
14,549	14,940	15,018	14,484	14,814	14,158	14,526	174,996
4,206	4,286	4,239	4,048	4,206	3,976	4,127	51,487
1,729	1,766	1,788	1,689	1,764	1,705	1,731	20,995
6,931	7,179	7,127	6,913	7,044	6,751	6,947	84,828
5,987	6,076	6,036	5,829	6,021	5,832	5,984	72,202
3,011	3,093	3,054	2,925	2,996	2,890	2,980	36,190
2,554	2,617	2,591	2,359	2,517	2,420	2,516	31,118
22,625	23,227	22,989	22,203	22,881	22,017	22,670	274,436
29,462	30,655	30,041	29,822	31,115	30,337	31,407	361,758
3,472	3,539	3,494	3,357	3,457	3,311	3,405	42,080
1,775	1,823	1,807	1,736	1,616	1,729	1,788	21,308
103,769	106,826	105,834	102,621	105,970	102,427	105,569	1,262,126
3,147	3,386	3,435	3,386	3,334	3,160	3,203	39,363
--	--	--	1	--	--	--	3
193	214	187	219	231	196	235	2,665
11,203	11,440	11,384	11,132	11,067	10,632	11,401	139,997
263,407	272,184	269,665	253,288	266,949	257,064	264,322	3,202,585
276,418	285,731	284,225	271,959	285,940	274,829	280,960	3,360,903
8,780	8,780	8,699	8,443	8,611	8,569	8,527	8,774
1,034	1,191	1,060	1,035	1,162	1,083	1,103	13,385
1,079	1,148	1,152	1,115	1,127	1,193	1,163	13,477
5,699	5,891	5,899	5,843	5,951	5,754	5,954	69,834
54	53	55	51	53	45	45	635
1,322	1,459	1,342	1,310	1,458	1,329	1,420	16,133
10,236	10,576	10,423	10,015	10,315	9,935	10,134	123,029
6,041	6,193	6,178	5,984	6,172	5,870	6,125	72,943
10,452	10,684	10,835	10,453	10,745	10,507	10,919	125,753

Table 6.—Production of crude petroleum (including lease

(Thousand

State	Jan.	Feb.	Mar.	Apr.	May
California—Continued:					
North	46	39	43	40	39
Total California	27,247	24,616	27,213	26,567	27,497
Colorado	2,924	2,800	3,174	3,444	3,307
Florida	3,262	3,053	3,478	3,556	3,529
Illinois	2,273	1,946	2,157	2,258	2,259
Indiana	385	336	359	362	378
Kansas	5,128	4,541	5,030	5,066	5,097
Kentucky	602	586	604	631	637
Louisiana:					
Gulf Coast	53,390	50,443	53,308	52,187	52,216
Rest of State	3,238	2,977	3,125	2,928	3,018
Total Louisiana	56,628	53,421	56,434	55,112	55,236
Michigan	1,761	1,548	1,834	1,746	1,869
Mississippi	4,043	3,690	4,035	3,844	3,874
Missouri	5	4	5	5	5
Montana	2,768	2,548	2,854	2,701	2,767
Nebraska	515	462	503	506	529
Nevada	12	10	11	10	11
New Mexico:					
Southeastern	7,571	6,859	7,594	7,265	7,489
Northwestern	619	551	589	567	604
Total New Mexico	8,190	7,409	8,184	7,831	8,091
New York	86	67	74	74	74
North Dakota	1,636	1,532	1,992	1,208	1,695
Ohio	803	728	663	689	879
Oklahoma	13,987	13,796	14,482	12,497	13,795
Pennsylvania	270	244	233	268	281
South Dakota	42	36	35	36	39
Tennessee	57	56	57	57	57
Texas:					
District 01	1,559	1,423	1,526	1,525	1,529
District 02	5,842	5,310	5,821	5,667	5,803
District 03	14,361	12,881	14,370	13,709	14,280
District 04	4,006	3,672	3,951	3,827	3,842
District 05	1,724	1,564	1,737	1,685	1,736
District 06, except East Texas	7,066	6,354	7,084	6,777	6,904
East Texas	5,996	5,370	5,954	5,717	5,895
District 07B	2,940	2,684	3,008	2,936	3,020
District 07C	3,341	3,019	3,394	3,256	3,299
District 08	21,460	19,422	21,701	20,903	21,319
District 08A	31,344	28,304	31,671	30,522	31,534
District 09	3,414	3,039	3,379	3,274	3,300
District 10	1,785	1,610	1,789	1,747	1,763
Total Texas	104,838	94,652	105,385	101,545	104,224
Utah	3,608	3,356	3,711	3,576	3,604
Virginia	1	--	--	--	1
West Virginia	226	199	204	227	212
Wyoming	12,272	11,289	12,247	11,775	11,288
Total United States:					
1975	262,104	240,552	263,297	253,698	259,742
1974	276,950	255,982	277,927	268,619	276,228
Daily average, 1975	8,455	8,591	8,493	8,457	8,379
Pennsylvania grade (included in U.S. total)	1,128	1,005	962	1,038	1,164

Sources of 1975 data:

Alabama	Alabama State Oil and Gas Board.
Alaska	Alaska Department of Natural Resources.
Arizona	Arizona Oil & Gas Commission.
Arkansas	Arkansas Oil and Gas Commission.
California	Division of Oil and Gas, California Department of Conservation.
Colorado	Colorado Oil & Gas Conservation Commission.
Florida	Florida Department of Natural Resources.
Illinois	Illinois State Geological Survey.
Indiana	Indiana Department of Natural Resources.
Kansas	Kansas Corporation Commission.
Kentucky	Kentucky Geological Survey.
Louisiana	Louisiana Department of Conservation and U.S. Geological Survey.
Michigan	Michigan Department of Natural Resources.
Mississippi	Mississippi State Oil and Gas Board.
Missouri	Missouri Geological Survey and Water Resources.
Montana	Montana Department of Natural Resources and Conservation.

condensate) in the United States, by State and month—Continued
barrels)

June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
37	38	40	40	40	38	34	474
26,765	27,493	27,476	26,491	27,273	26,349	27,212	322,199
3,220	3,293	3,208	3,175	3,226	3,076	3,242	38,089
3,532	3,645	3,561	3,386	3,710	3,528	3,637	41,877
2,176	2,155	2,177	2,170	2,248	2,032	2,216	26,067
371	513	35[illegible]	387	403	354	426	4,632
4,828	5,058	4,91[illegible]	4,856	5,063	4,426	5,094	59,106
630	662	63[illegible]	648	668	596	661	7,556
51,091	51,714	50,487	47,606	51,506	49,582	49,972	613,502
2,948	3,138	3,251	3,072	3,217	3,131	3,295	37,338
54,040	54,853	53,737	50,678	54,723	52,714	53,264	650,840
1,943	2,196	2,153	2,246	2,404	2,327	2,393	24,420
3,835	3,954	3,938	3,793	3,963	3,783	3,862	46,614
4	5	5	5	5	4	5	57
2,682	2,707	2,793	2,777	2,779	2,694	2,774	32,844
523	539	523	509	520	486	505	6,120
10	10	9	7	8	9	8	115
7,239	7,447	7,449	7,276	7,555	7,411	7,410	88,565
554	541	511	498	537	380	547	6,498
7,792	7,988	7,961	7,774	8,092	7,794	7,957	95,063
69	74	70	71	68	75	73	875
1,676	1,774	1,800	1,758	1,798	1,772	1,811	20,452
827	857	821	812	729	908	862	9,578
13,703	13,687	12,964	13,995	13,561	13,169	13,487	163,123
316	287	265	294	297	263	246	3,264
37	42	37	38	39	34	57	472
57	57	57	57	57	56	57	682
1,461	1,525	1,536	1,514	1,607	1,562	1,621	18,388
5,601	5,763	5,703	5,493	5,674	5,494	5,656	67,827
13,712	14,079	14,099	13,585	14,007	13,491	13,964	166,538
3,677	3,690	3,680	3,501	3,575	3,376	3,704	44,501
1,689	1,735	1,737	1,624	1,683	1,665	1,668	20,247
6,790	6,871	6,853	6,651	6,865	6,552	6,803	81,570
5,689	5,804	5,763	5,657	5,786	5,587	5,806	69,024
2,888	2,961	2,953	2,850	2,967	2,849	2,959	35,015
3,172	3,270	3,300	3,224	3,367	3,244	3,339	39,225
20,410	20,990	21,053	20,379	21,309	20,391	20,913	250,250
30,254	31,419	31,318	30,410	31,166	30,573	31,463	369,978
3,182	3,234	3,216	3,109	3,267	3,108	3,246	38,768
1,679	1,705	1,693	1,661	1,744	1,643	1,779	20,598
100,204	103,046	102,904	99,658	103,017	99,535	102,921	1,221,929
3,593	3,640	3,593	3,477	3,516	3,285	3,342	42,301
--	--	--	1	--	--	--	3
209	216	186	183	213	183	221	2,479
11,428	11,106	11,118	10,824	11,088	10,563	10,945	135,943
252,624	258,408	255,712	248,389	258,057	248,336	255,860	3,056,779
263,407	272,184	269,665	253,288	266,949	257,064	264,322	3,202,585
8,421	8,336	8,249	8,280	8,324	8,278	8,254	8,375
1,157	1,160	1,080	1,100	1,074	1,139	1,127	13,134

Nebraska ---------------Nebraska Oil and Gas Conservation Commission.
Nevada ----------------Nevada Bureau of Mines and Geology.
New Mexico -----------New Mexico Oil Conservation Commission.
New York -------------New York State Geological Survey.
North Dakota ----------North Dakota Geological Survey.
Ohio ------------------Ohio Department of Natural Resources.
Oklahoma --------------Oklahoma Corporation Commission and Oklahoma Tax Commission.
Pennsylvania ----------Pennsylvania Bureau of Topographic and Geologic Survey.
South Dakota ----------South Dakota Geological Survey.
Tennessee -------------Tennessee Department of Conservation.
Texas -----------------The Railroad Commission of Texas.
Utah ------------------Utah Oil and Gas Conservation Commission.
Virginia --------------Division of Mines and Quarries, Virginia Department of Labor and Industry.
West Virginia ---------West Virginia Department of Mines.
Wyoming ---------------Wyoming State Oil and Gas Conservation Commission.

Table 7.—Percentage of total U.S. crude petroleum produced, by State

State	1971	1972	1973	1974	1975
Texas	35.4	37.7	38.5	39.4	40.0
Louisiana	27.1	25.8	24.7	23.0	21.3
California	10.4	10.0	10.0	10.1	10.5
Oklahoma	6.2	6.0	5.7	5.5	5.3
Wyoming	4.3	4.0	4.2	4.4	4.4
New Mexico	3.4	3.2	3.0	3.1	3.1
Alaska	2.3	2.1	2.2	2.2	2.3
Kansas	2.3	2.1	2.0	1.9	1.9
Mississippi	1.9	1.8	1.7	1.6	1.5
Utah	.7	.8	1.0	1.2	1.4
Florida	.2	.5	1.0	1.1	1.4
Colorado	.8	.9	1.1	1.2	1.2
Montana	1.0	1.0	1.0	1.1	1.1
Illinois	1.1	1.0	.9	.9	.9
Michigan	.3	.4	.4	.6	.8
North Dakota	.6	.6	.6	.6	.7
Arkansas	.5	.5	.5	.5	.5
Alabama	.2	.3	.3	.4	.4
Ohio	.2	.3	.3	.3	.3
Other States	1.1	1.0	.9	.9	1.0
Total	100.0	100.0	100.0	100.0	100.0

Table 8.—Well completions in the United States, by quarter[1]

	1st quarter	2d quarter	3d quarter	4th quarter	Total	
					Number	Percent
1974:						
Oil	2,590	3,152	3,417	3,625	12,784	40.3
Gas[2]	1,805	1,802	1,622	2,011	7,240	22.9
Dry	2,584	2,743	2,914	3,433	11,674	36.8
Total	6,979	7,697	7,953	9,069	31,698	100.0
1975:						
Oil	3,742	3,525	4,012	5,129	16,408	44.0
Gas[2]	1,782	1,469	1,984	2,345	7,580	20.4
Dry	3,035	2,971	3,183	4,058	13,247	35.6
Total	8,559	7,965	9,179	11,532	37,235	100.0

[1] Excludes service wells. Data by quarters adjusted to agree with annual totals.
[2] Includes condensate wells.

Source: American Petroleum Institute.

Table 9.—Well completions in the United States, by State[1]

State and district	1974 Oil	1974 Gas[2]	1974 Dry	1974 Total	1975 Oil	1975 Gas[2]	1975 Dry	1975 Total
Alabama	16	16	66	98	20	26	64	110
Alaska	27	4	7	38	44	4	15	63
Arizona	3	--	8	11	--	--	2	2
Arkansas	99	41	177	317	147	23	151	321
California	1,567	69	314	1,950	1,854	46	304	2,204
Colorado	218	201	417	836	328	300	563	1,191
Florida	9	--	36	45	15	--	31	46
Georgia	--	--	5	5	--	--	3	3
Idaho	--	--	2	2	--	--	1	1
Illinois	357	11	427	795	460	5	491	956
Indiana	136	21	219	376	145	17	211	373
Iowa	--	--	2	2	--	--	--	--
Kansas	989	389	1,312	2,690	1,094	438	1,527	3,059
Kentucky	195	127	336	658	304	123	491	918
Louisiana:								
North	326	458	387	1,171	402	413	413	1,228
South	283	190	465	938	373	220	569	1,162
Offshore	216	141	304	661	181	182	283	646
Total Louisiana	825	789	1,156	2,770	956	815	1,265	3,036
Maryland	--	1	1	2	--	--	1	1
Michigan	116	52	234	402	169	33	314	516
Mississippi	67	26	349	442	83	31	337	451
Missouri	7	2	23	32	6	1	15	22
Montana	60	145	467	672	100	279	531	910
Nebraska	40	5	185	230	74	1	263	338
Nevada	--	--	2	2	--	--	4	4
New Mexico:								
West	53	252	63	368	71	357	72	500
East	297	211	252	760	366	160	187	713
Total New Mexico	350	463	315	1,128	437	517	259	1,213
New York	153	98	41	292	142	236	16	394
North Carolina	--	--	11	11	--	--	2	2
North Dakota	42	--	85	127	69	--	138	207
Ohio	567	1,050	171	1,788	550	555	115	1,220
Oklahoma	1,149	744	1,164	3,057	1,743	638	1,265	3,646
Oregon	--	--	--	--	--	--	--	--
Pennsylvania	671	468	69	1,208	691	640	68	1,399
South Dakota	1	--	10	11	5	--	19	24
Tennessee	61	12	62	135	46	38	119	203

See footnotes at end of table.

Table 9.—Well completions in the United States, by State[1]—Continued

State and district	1974 Oil	1974 Gas[2]	1974 Dry	1974 Total	1975 Oil	1975 Gas[2]	1975 Dry	1975 Total
Texas:								
District 1	252	96	207	555	499	109	217	825
District 2	77	290	312	679	108	323	347	778
District 3	369	162	412	943	378	213	392	983
District 4	230	326	320	876	187	409	385	981
District 5	33	15	90	138	40	25	91	156
District 6	88	71	135	294	152	70	148	370
District 7B	444	183	542	1,169	570	227	686	1,483
District 7C	414	282	225	921	516	293	314	1,123
District 8	1,058	127	164	1,349	1,493	150	201	1,844
District 8A	619	25	193	837	931	16	243	1,190
District 9	626	100	401	1,127	982	84	528	1,594
District 10	191	145	142	478	218	204	165	587
Offshore	1	21	141	163	--	12	160	172
Total Texas	4,402	1,843	3,284	9,529	6,074	2,135	3,877	12,086
Utah	118	12	65	195	110	19	65	194
Virginia	--	55	6	61	2	26	8	36
West Virginia	121	556	102	779	120	556	115	791
Wyoming	418	40	530	988	620	78	565	1,263
Gulf of Mexico, northern[3]	--	--	14	14	--	--	32	32
Total United States	12,784	7,240	11,674	31,698	16,408	7,580	13,247	37,235

[1] Excludes service wells.
[2] Includes condensate wells.
[3] Gulf of Mexico, Northern is a new area, designated by the Bureau of Land Management for federally controlled Outer Continental Shelf (OCS) waters not previously mapped or leased. The area covers Gulf of Mexico OCS waters off the States of Texas, Louisiana, Mississippi, Alabama, and Florida.

Source: American Petroleum Institute.

Table 10.—Producing oil wells in the United States and average production per well per day, by State

State	Producing oil wells 1974: Approximate number of oil wells producing Dec. 31	1974: Average production per well per day (barrels)[1]	1975: Approximate number of oil wells producing Dec. 31	1975: Average production per well per day (barrels)[1]
Alabama	582	62.5	608	62.1
Alaska	199	989.4	205	947.2
Arizona	25	76.5	28	65.7
Arkansas	7,235	6.3	7,308	6.1
California:				
South	8,923	38.8	8,758	38.1
Central coastal	6,022	35.2	6,108	33.0
East central	25,468	13.4	26,095	13.4
North	66	23.6	68	19.4
Total California	40,479	22.4	41,029	21.7
Colorado	2,174	49.2	2,450	45.1
Florida	136	703.8	143	822.4
Illinois	23,630	3.1	23,373	3.0
Indiana	[2] 4,376	3.1	4,798	2.8
Kansas	[2] 41,755	4.1	41,945	3.9
Kentucky	14,127	1.5	13,905	1.5
Louisiana:				
Gulf coast	[2] 12,858	147.5	[2] 12,535	132.4
Northern	[2] 15,115	7.1	[2] 15,199	6.7
Total Louisiana	[2] 27,973	72.3	[2] 27,734	64.0
Michigan	4,201	12.4	3,655	17.0
Mississippi	2,254	54.0	[2] 2,237	56.9
Montana	3,103	28.8	3,247	28.3
Nebraska	1,127	16.2	1,190	14.5
New Mexico:				
Southwestern	12,274	17.9	12,625	19.5
Northwestern	1,030	16.7	1,090	16.8
Total New Mexico	13,304	17.8	13,715	19.3
New York	[2] 5,475	.5	[2] 4,975	.5
North Dakota	[2] 1,488	37.3	1,994	32.2
Ohio	16,658	1.6	16,611	1.6
Oklahoma	71,797	6.7	71,576	6.2
Pennsylvania	32,095	.3	32,095	.3
South Dakota	31	46.7	38	37.5
Tennessee	154	19.1	172	11.5
Texas:				
District 01	10,320	5.2	10,546	4.8
District 02	4,488	43.2	4,544	41.2
District 03	9,769	49.5	9,564	47.2
District 04	7,103	20.5	7,097	17.2
District 05	2,557	23.2	2,573	21.6
District 06, except East Texas	5,059	46.3	4,961	44.6
East Texas	13,207	14.8	12,902	14.5
District 07B	10,179	9.7	10,336	9.4
District 07C	7,449	11.5	7,564	14.3
District 08	35,895	21.1	36,337	19.0
District 08A	17,493	57.3	18,116	56.9
District 09	24,579	4.6	24,419	4.3
District 10	11,604	5.0	11,644	4.9
Total Texas	159,702	21.7	160,603	20.9
Utah	[2] 1,076	104.4	1,323	96.6
West Virginia	[2] 13,650	.5	[2] 13,750	.5
Wyoming	[2] 8,656	47.1	[2] 9,450	41.1
Other States:				
Missouri	157	1.1	163	1.0
Nevada	9	47.1	6	42.0
Virginia	3	5.5	7	1.6
Total United States	497,631	17.6	500,333	16.8

[1] Based on the average number of wells during the year.
[2] Estimated by Bureau of Mines; all other numbers of producing oil wells furnished by State agencies.

Table 11.—Production and reserves of crude petroleum in leading fields in the United States

(Thousand barrels)

Field [1]	State	Production		Total since discovery [2]	Estimated reserves
		1974	1975		
Wasson	Texas	86,784	93,763	972,886	535,690
Kelly-Snyder	do	76,433	72,706	832,501	517,499
East Texas	do	72,312	68,731	4,310,446	1,689,554
Wilmington	California	65,382	65,623	1,747,359	632,000
Slaughter	Texas	47,033	46,250	641,715	115,750
McArthur River	Alaska	39,191	41,132	294,473	208,500
Hawkins	Texas	39,630	40,750	576,447	248,553
Midway Sunset	California	4,920	37,080	1,264,590	380,000
Jay	Florida	33,166	33,825	109,208	233,792
Sho-Vel-Tum	Oklahoma	34,250	32,600	1,035,056	264,944
Hasting, East and West	Texas	27,912	27,936	530,927	225,276
Eugene Island Block 330	Louisiana	19,747	27,903	68,391	162,851
Kern River	California	26,765	27,712	662,232	800,000
Webster	Texas	24,762	25,075	438,033	200,925
Tom O'Connor	do	25,667	24,770	521,180	178,820
Seminole All	do	20,102	23,929	243,276	71,724
Bay Marchand Block 2	Louisiana	32,632	22,416	451,950	198,050
Greater Altamont	Utah	21,898	22,115	681,312	206,320
Conroe	Texas	21,737	21,375	562,034	174,966
Rangely	Colorado	20,284	20,481	534,826	179,168
Spraberry Trend	Texas	18,190	18,611	398,244	111,756
Yates	do	18,192	18,093	623,539	976,463
West Delta Block 30	Louisiana	22,586	17,731	330,193	119,807
Grand Isle Block 43	do	20,999	17,592	181,261	188,811
Huntington Beach	California	19,035	17,234	941,025	125,000
Cowden North	Texas	14,954	16,479	293,299	148,521
Goldsmith All	do	17,431	16,475	595,133	79,867
Cowden South (Foster, Johnson)	do	16,714	16,010	315,623	84,377
Van and Van Shallow	do	16,264	15,978	435,362	114,638
Thompson All	do	16,319	15,294	385,365	114,635
Empire Abo	New Mexico	12,267	15,225	126,396	73,604
Caillou Island	Louisiana	18,023	14,035	530,933	190,965
West Ranch	Texas	14,560	13,834	285,246	82,754
Levelland	do	12,391	13,830	246,338	108,662
San Ardo	California	12,877	13,828	288,008	120,000
Dos Cuadras	do	14,990	13,697	115,940	79,000
Cogdell Area	Texas	10,237	13,163	201,081	118,919
South Pass Block 24	Louisiana	15,223	12,868	384,344	105,656
Vacuum	New Mexico	13,152	12,519	287,505	112,495
McElroy	Texas	11,820	12,114	321,632	87,886
Salt Creek	do	13,093	11,726	138,389	91,611
Panhandle	do	12,347	11,470	1,295,055	119,945
Grand Isle Block 16	Louisiana	13,156	11,377	222,429	127,571
Oregon Basin	Wyoming	11,354	11,305	251,620	88,346
Ventura	California	11,393	11,286	804,644	97,000
Fairway	Texas	13,741	11,214	134,917	78,020
Salt Creek	Wyoming	13,284	9,839	552,446	67,185
South Pass Block 27	Louisiana	11,568	9,528	268,454	116,546
Belridge South	California	8,544	9,347	204,178	78,000
Sooner Trend	Oklahoma	9,810	9,140	208,554	55,446
Main Pass Block 41	Louisiana	10,396	9,058	153,576	126,423
West Delta Block 58	do	10,035	9,026	47,117	152,883
Swanson River	Alaska	9,741	8,676	162,998	60,200
Bell Creek	Montana	9,345	8,615	77,438	38,989
Middle Ground Shoal	Alaska	9,033	8,584	96,247	89,300
South Pass Block 65	Louisiana	10,105	8,471	54,664	135,336
Ship Shoal Block 208	do	10,559	8,361	100,867	124,133
Greater Aneth	Utah	7,927	8,302	268,556	47,556
West Delta Block 73	Louisiana	7,654	8,268	136,487	138,513
Elk Basin	Wyoming	8,887	8,007	457,554	60,647
West Cote Blanche Bay	Louisiana	7,880	7,877	155,193	94,807
Garden Island Bay	do	8,403	7,504	182,333	74,004
Anahuac	Texas	8,949	7,462	256,221	98,779
Anton-Irish	do	4,800	7,416	81,143	33,696
Fullerton All	do	6,756	7,127	245,544	145,873

[1] Fields under 7 million barrels not shown for current year.
[2] Includes revisions, if any.

Source: Oil and Gas Journal. All figures are preliminary.

Table 12.—Estimates of proved crude oil reserves in the United States on December 31, by State [1]

(Million barrels)

State	1971	1972	1973	1974	1975
Eastern States:					
Illinois	209	175	152	160	161
Indiana	31	29	27	24	22
Kentucky	52	48	40	37	39
Michigan	59	62	72	82	93
New York	10	9	8	11	10
Ohio	129	127	125	124	121
Pennsylvania	47	37	40	50	48
West Virginia	52	34	32	32	32
Total	589	521	496	520	526
Central and southern States:					
Alabama	61	57	54	69	61
Arkansas	118	113	106	106	96
Florida	204	208	184	303	263
Kansas	502	453	401	395	364
Louisiana [2]	5,399	5,029	4,577	4,227	3,827
Mississippi	342	313	291	261	231
Nebraska	36	31	28	27	28
New Mexico	657	583	643	625	588
North Dakota	174	166	179	173	158
Oklahoma	1,405	1,303	1,271	1,232	1,240
Texas [2]	13,023	12,144	11,757	11,002	10,080
Total	21,921	20,400	19,491	18,420	16,936
Mountain States:					
Colorado	333	326	305	289	276
Montana	228	241	219	207	164
Utah	166	244	264	251	208
Wyoming	997	950	917	903	877
Total	1,724	1,761	1,705	1,650	1,525
Pacific coast States:					
Alaska	[4] 10,116	[4] 10,096	[4] 10,112	10,094	10,037
California [2]	3,706	3,554	3,488	3,557	3,648
Total [1]	13,822	13,650	13,600	13,651	13,685
Other States [3]	7	7	8	9	10
Total United States	38,063	36,339	35,300	34,250	32,682

[1] From reports of Committee on Petroleum Reserves, American Petroleum Institute. Included are estimated quantities of crude oil which geological and engineering data demonstrate with reasonable certainty to be recoverable from known reservoirs under existing economic and operating conditions.

[2] Includes offshore reserves.

[3] Includes Arizona, Missouri, Nevada, South Dakota, Tennessee, and Virginia.

[4] These data include the estimate of proved reserves in the Prudhoe Bay Permo-Triassic reservoir, discovered in 1968. The estimate is based on the analysis of extensive engineering and geologic data; however, revisions may be required when actual production performance becomes available.

Table 13.—Refinery receipts of domestic

(Thousand

Location of refineries receiving crude oil	Total receipts of domestic crude oil	Intra-state receipts	Interstate						
			PAD district I, total [1]	District II					
				Ill., Ind., Mich.	Kans.	Ky., Ohio, Tenn.	Nebr., N. Dak., S. Dak.	Okla.	Total
District I:									
Delaware and Maryland	5,153	--	4,975	--	--	--	--	--	--
Florida, Georgia, Virginia	831	--	--	--	--	--	--	--	--
New Jersey	11,954	--	670	--	--	--	--	--	--
New York	6,545	--	--	2,344	111	--	--	--	2,455
Pennsylvania:									
East	14,233	--	1,932	--	--	--	--	--	--
West	16,553	3,081	945	1,582	701	5,855	--	876	9,014
West Virginia	5.715	2,356	--	--	--	3,359	--	--	3,359
Total	60,984	5,437	8,522	3,926	812	9,214	--	876	14,828
District II:									
Illinois	268,322	15,461	200	--	2,629	--	1,303	17,151	21,083
Indiana	133,225	1,469	429	2,468	2,752	732	5,515	10,971	22,438
Kansas	133,510	60,707	--	--	--	--	740	25,926	26,666
Kentucky and Tennessee	45,422	3,660	3,044	8,055	--	96	--	--	8,151
Michigan	32,368	17,032	--	--	--	--	--	--	--
Minnesota and Wisconsin	8,768	--	--	--	--	--	4,489	406	4,895
Missouri and Nebraska	33,440	--	--	--	327	--	--	2,438	2,765
North Dakota	14,616	13,312	--	--	--	--	--	--	--
Ohio:									
East	8,281	--	--	752	--	--	--	7	759
West	121,684	59	--	9,459	--	--	--	595	10,054
Oklahoma	164.008	114,305	--	--	1,024	--	--	--	1,024
Total	963,644	226.005	3,673	20.734	6,732	828	12,047	57,494	97,835
District III:									
Alabama	12,696	1,796	5,807	--	--	--	--	--	--
Arkansas	19,200	13.292	--	--	--	--	--	--	--
Louisiana	462,921	362,207	11,794	--	--	--	--	165	165
Mississippi	59,889	15,469	--	--	--	--	--	--	--
New Mexico	29,034	28,633	--	--	--	--	--	--	--
Texas	903.812	765,811	12.786	--	353	--	--	4.912	5,265
Total	1,487,552	1,187.208	30,387	--	353	--	--	5,077	5,430
District IV:									
Colorado	16,037	4,498	--	--	--	--	--	--	--
Montana	29,583	9,766	--	--	--	--	12	--	12
Utah	42,818	17,736	--	--	--	--	--	--	--
Wyoming	50.438	47,338	--	--	--	--	--	--	--
Total	138,876	79,338	--	--	--	--	12	--	12
District V:									
California	371,627	313,639	--	--	--	--	--	--	--
Other States	25,059	20,736	--	--	--	--	--	--	--
Total	396,686	334,375	--	--	--	--	--	--	--
Total United States	3,047,742	1,832,363	42,582	24,660	7,897	10,042	12,059	63,447	118,105
Daily average	8,327	5,006	116	68	22	27	33	173	323

[1] Includes receipts from Florida, 41,595; New York, 790; West Virginia, 197.
[2] Includes receipts from Alaska, 47,404; Arizona, 28; California, 993; Nevada, 12.

crude oil in 1975, by State and PAD district

barrels)

receipts from—

District III					District IV					District V total [2]	Total interstate receipts
Ala., Ark., Miss.	La.	N. Mex.	Tex.	Total	Colo.	Mont.	Utah	Wyo.	Total		
--	178	--	--	178	--	--	--	--	--	--	5,153
813	18	--	--	831	--	--	--	--	--	--	831
603	2,179	--	8,502	11,284	--	--	--	--	--	--	11,954
--	2,671	--	1,331	4,002	88	--	--	--	88	--	6,545
997	660	--	10,644	12,301	--	--	--	--	--	--	14,233
--	838	--	954	1,792	--	769	--	952	1,721	--	13,472
--	--	--	--	--	--	--	--	--	--	--	3,359
2,413	6,544	--	21,431	30,388	88	769	--	952	1,809	--	55,547
2,394	55,501	36,383	114,910	209,188	2,539	2,236	804	16,811	22,390	--	252,861
--	16,351	11,285	59,808	87,444	694	10,907	--	9,844	21,445	--	131,756
738	79	--	21,032	21,849	3,044	1,020	1,022	19,202	24,288	--	72,803
876	23,859	--	4,896	29,631	--	--	--	936	936	--	41,762
61	7,372	--	--	7,433	--	--	--	7,903	7,903	--	15,336
--	--	--	1,211	1,211	--	2,026	--	636	2,662	--	8,768
--	--	2,870	26,059	28,929	16	654	--	1,076	1,746	--	33,440
--	--	--	--	--	--	1,304	--	--	1,304	--	1,304
--	5,145	--	2,317	7,462	--	--	--	60	60	--	8,281
2,729	46,632	1,498	56,515	107,374	38	59	--	4,100	4,197	--	121,625
--	--	2,439	45,280	47,719	94	--	235	631	960	--	49,703
6,798	154,939	54,475	332,028	548,240	6,425	18,206	2,061	61,199	87,891	--	737,639
5,040	53	--	--	5,093	--	--	--	--	--	--	10,900
--	813	--	5,095	5,908	--	--	--	--	--	--	5,908
15,746	46	--	72,963	88,755	--	--	--	--	--	--	100,714
--	44,420	--	--	44,420	--	--	--	--	--	--	44,420
--	--	--	--	--	367	--	6	--	373	28	401
9,809	94,262	10,775	--	114,846	1,626	--	3,257	--	4,883	221	138,001
30,595	139,594	10,775	78,058	259,022	1,993	--	3,263	--	5,256	249	300,344
--	--	--	--	--	--	256	2,797	8,486	11,539	--	11,539
--	--	--	--	--	--	--	--	19,805	19,805	--	19,817
--	--	--	--	--	17,372	784	--	6,926	25,082	--	25,082
--	--	3	--	3	1,784	498	815	--	3,097	--	3,100
--	--	3	--	3	19,156	1,538	3,612	35,217	59,523	--	59,538
--	--	--	--	--	1,896	--	11,619	--	13,515	44,473	57,988
--	--	--	--	--	--	--	608	--	608	3,715	4,323
--	--	--	--	--	1,896	--	12,227	--	14,123	48,188	62,311
39,806	301,077	65,253	431,517	837,653	29,558	20,513	21,163	97,368	168,602	48,437	1,215,379
109	823	178	1,179	2,289	81	56	58	266	461	132	3,321

Table 14.—Crude oil input to refineries and refinery receipts of crude oil, by origin of the crude and method of transportation

(Thousand barrels)

District and State	Crude oil input to refineries	Refinery fuel use and losses	By State of origin of domestic crude	Change in refinery stocks	Refinery receipts of domestic crude by receiving State and method of transportation: Intrastate			Interstate			Refinery receipts of foreign crude	
					Pipelines	Tank cars and trucks	Tankers and barges	Pipelines	Tank cars and trucks	Tankers and barges	Pipelines	Tankers and barges
District I:												
Delaware and Maryland	49,925	--	--	−275	--	--	--	--	--	5,153	--	44,497
Florida, Georgia. Virginia	23,278	4	41,595	−468	--	--	--	--	800	31	--	21,983
New Jersey and Rhode Island	189,233	78	--	+764	--	--	--	--	--	11,954	--	178,121
New York and New Hampshire	31,238	−1	790	+339	--	--	--	6,545	--	--	23,176	1,855
Pennsylvania:												
East	192,411	103	--	−1,917	--	--	--	--	--	14,233	4,429	171,935
West	21,998	9	3,081	+99	2,027	1,054	--	7,205	4,704	1,563	5,553	--
West Virginia	5,720	−5	2,553	--	2,287	69	--	1,432	740	1,187	--	--
Total	[1] 513,803	188	48,019	−1,458	4,314	1,123	--	15,182	6,244	34,121	33,158	418,391
District II:												
Illinois	357,870	64	33,711	+586	15,157	304	--	252,861	--	--	90,198	--
Indiana	163,277	57	1,469	+280	1,397	72	--	129,150	91	2,515	30,389	--
Kansas	141,119	5	68,604	−194	59,345	1,362	--	71,784	1,019	--	7,420	--
Kentucky and Tennessee	70,423	79	4,475	−79	2,560	1,100	--	27,520	95	14,147	24,842	159
Michigan	41,318	1	23,442	+297	15,893	1,139	--	15,336	--	--	9,248	--
Minnesota and Wisconsin	69,201	--	--	−235	--	--	--	8,768	--	--	60,198	--
Missouri and Nebraska	33,833	--	4,331	+7	--	--	--	33,414	26	--	400	--
North Dakota, South Dakota	17,796	−1	21,040	+106	13,204	108	--	1,263	41	--	3,285	--
Ohio:												
East	20,897	--	9,227	−23	--	--	--	8,281	--	--	12,593	--
West	[2] 162,686	1	59	−269	59	--	--	121,625	--	--	[2] 40,734	--
Oklahoma	167,132	22	177,752	+61	110,459	3,846	--	49,703	--	--	3,207	--
Total	1,245,552	228	344,110	+537	218,074	7,931	--	719,705	1,272	16,662	282,514	159

District III:												
Alabama	13,169	85	12,179	+113	533	602	661	10,302	139	459	--	671
Arkansas	19,211	2	14,155	−13	12,666	626	--	5,902	6	--	--	--
Louisiana	549,790	178	663,284	+2,112	276,916	5,122	80,169	91,273	1,329	8,112	--	89,159
Mississippi	98,253	--	44,029	+236	13,723	1,746	--	44,420	--	--	--	38,600
New Mexico	29,039	43	93,886	−48	24,775	3,858	--	54	347	--	--	--
Texas	1,210,366	155	1,197,328	+1,910	733,448	15,143	17,220	73,844	142	64,015	5,258	303,361
Total	1,919,828	463	2,024,861	+4,310	1,062,061	27,097	98,050	225,795	1,963	72,586	5,258	431,791
District IV:												
Colorado	16,204	--	34,056	−5	2,463	2,035	--	8,742	2,797	--	162	--
Montana	42,589	--	30,279	−350	8,795	971	--	19,805	12	--	[3] 12,656	--
Utah	42,797	3	38,899	+18	13,359	4,377	--	23,528	1,554	--	--	--
Wyoming	53,805	5	144,706	+195	46,376	962	--	1,871	1,229	--	3,567	--
Total	155,395	8	247,940	−142	70,993	8,345	--	53,946	5,592	--	16,385	--
District V:												
California	562,462	334	314,632	+21	265,152	11,680	36,807	6,886	8,018	43,084	--	191,190
Washington	105,792	−1	--	+340	--	--	--	--	--	3,683	59,694	42,754
Other States [4]	38,594	40	68,180	−61	20,411	325	--	--	608	32	509	16,688
Total	706,848	373	382,812	+300	285,563	12,005	36,807	6,886	8,626	46,799	60,203	250,632
Total United States	4,541,426	1,260	3,047,742	+3,547	1,641,005	56,501	134,857	1,021,514	23,697	170,168	[5] 397,518	1,100,973
Daily average	12,408	3	8,327	+10	4,484	154	368	2,791	65	465	1,086	3,008

[1] Includes 296,432,000 barrels in Delaware River Valley.
[2] Includes some Athabasca hydrocarbons.
[3] Includes 43 by truck.
[4] Includes Alaska, Arizona, Hawaii, Nevada and Oregon.
[5] Excludes crude oil imported for direct burning for fuel use by pipeline.

Table 15.—Supply, demand, and stocks change of refined products, 1975

(Thousand barrels per day)

	PAD district						United States
	I	II	III	IV	Total I–IV	V	
Supply:							
Refinery output	1,522	3,545	5,403	444	10,914	2,023	12,937
Natural gas liquids output	35	236	1,282	51	1,604	28	1,632
Unfinished oils rerun	−53	+4	+25	−8	−32	−3	−35
Other hydrocarbons and crude transfers	3	5	26	2	36	19	55
Receipts from other districts:							
District I	--	179	4	--	--	--	--
District II	87	--	79	13	--	--	--
District III	2,903	635	--	35	--	73	--
District IV	--	27	13	--	--	68	--
District V	1	--	3	19	23	--	--
Imports	1,578	135	55	34	1,802	119	1,921
Total new supply	−33	+19	+18	590	14,347	2,327	16,510
Stock change [1]	6,076	4,766	6,890	−2	+2	+13	+15
Total supply	6,109	4,747	6,872	592	16,345	2,314	16,495
Exports	15	12	97	--	124	80	204
Shipments to other districts:							
District I	--	87	2,903	--	--	1	--
District II	179	--	635	27	--	--	--
District III	4	79	--	13	--	3	--
District IV	--	13	35	--	--	19	--
District V	--	--	73	68	141	--	--
Domestic product demand	5,911	4,556	3,129	484	14,080	2,211	16,291

[1] Plus sign represents a stocks increase, which is subtracted from total new supply; minus sign represents a stocks decrease, which is added to total new supply.

Table 16.—Supply and distribution of crude oil, 1975

(Thousand barrels per day)

	PAD district						United States
	I	II	III	IV	Total I–IV	V	
Crude oil supply:							
Domestic production including lease condensate	133	883	5,600	683	7,299	1,076	8,375
Receipts from other districts:							
District I	--	10	84	--	--	--	--
District II	41	--	15	--	--	--	--
District III	83	1,502	--	--	--	--	--
District IV	5	241	14	--	--	39	--
District V	--	--	1	--	1	--	--
Imports	1,237	774	1,198	44	3,253	852	4,105
Total new supply	1,499	3,410	6,912	727	10,553	1,967	12,480
Stocks change [1]	−3	+10	+7	+2	+16	+2	+18
Total supply	1,502	3,400	6,905	725	10,537	1,965	12,462
Crude oil distribution:							
Crude runs to stills	1,407	3,412	5,260	426	10,505	1,937	12,442
Transfers to products	--	2	6	1	9	8	17
Shipments to other districts:							
District I	--	41	83	5	--	--	--
District II	10	--	1,502	241	--	--	--
District III	84	15	--	14	--	1	--
District IV	--	--	--	--	--	--	--
District V	--	--	--	39	39	--	--
Exports	--	--	6	--	6	--	6
Losses	2	3	7	--	12	1	13
Crude oil unaccounted for	1	73	−41	1	34	−18	16

[1] Plus sign represents a stocks increase, which is subtracted from total supply; minus sign represents a stocks decrease, which is added to total new supply.

Table 17.—Supply and disposition of crude petroleum (including lease condensate) in the United States, by month

(Thousand barrels)

Supply and disposition	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1974													
Supply:													
Production	276,950	255,982	277,927	268,619	276,228	263,407	272,184	269,665	253,288	266,949	257,064	264,322	3,202,585
Imports [1]	73,839	62,940	76,329	98,011	121,139	117,747	126,835	121,634	113,907	118,096	118,739	119,939	1,269,155
Total new supply	350,789	318,922	354,256	366,630	397,367	381,154	399,019	391,299	367,195	385,045	375,803	384,261	4,471,740
Change in stocks, end of period:													
Domestic crude	−4,892	+8,572	+4,044	+6,498	+5,539	−1,677	+359	−2,984	−1,480	+6,751	−412	−6,560	+13,758
Foreign crude	−4,551	−884	−102	+5,222	+7,531	+987	−438	−862	+3,366	−4,040	+2,119	+436	+8,784
Unaccounted for [2]	−2,532	+714	+2,484	+607	−918	−33	−1,109	−2,324	−784	−597	−3,148	−1,444	−9,084
Disposition by use:													
Runs of domestic crude	277,845	247,059	275,625	261,931	268,734	264,162	269,877	269,506	253,147	258,750	253,353	268,607	3,168,596
Runs of foreign crude	78,361	63,804	76,383	92,758	113,597	116,750	127,265	122,472	110,564	122,104	116,595	119,477	1,260,130
Exports [3]	534	281	--	15	200	44	--	--	--	--	--	--	1,074
Transfers:													
Distillate	61	56	52	55	72	89	62	70	63	74	55	65	774
Residual	513	407	356	373	364	355	358	351	357	398	545	374	4,751
Crude losses	386	341	382	385	412	411	427	422	394	411	400	418	4,789
Total disposition by use	357,700	311,948	352,798	355,517	383,379	381,811	397,989	392,821	364,525	381,737	370,948	388,941	4,440,114
1975 p													
Supply:													
Production	262,104	240,552	263,297	253,698	259,742	252,624	258,408	255,712	248,389	258,057	248,336	255,860	3,056,779
Imports [1]	124,901	107,194	113,345	101,338	108,072	117,142	129,966	142,016	140,675	136,068	138,703	138,761	1,498,181
Total new supply	387,005	347,746	376,642	355,036	367,814	369,766	388,374	397,728	389,064	394,125	387,039	394,621	4,554,960
Change in stocks, end of period:													
Domestic crude	+1,129	+4,068	+5,208	+4,468	−2,568	−4,820	−9,418	−7,324	+289	+8,645	+1,745	+1,427	+2,849
Foreign crude	+4,313	+2,225	−1,974	−2,549	+1,621	−9	−2,557	−217	+2,541	+1,493	−379	−1,023	+3,485
Unaccounted for [2]	+1,301	+55	−3,214	+1,840	+3,633	−1,196	+1,063	+44	+3,259	+280	−3,918	+2,901	+6,048
Disposition by use:													
Runs of domestic crude	260,626	234,831	253,763	250,253	265,044	255,368	267,858	262,284	250,231	248,760	241,607	256,389	3,047,014
Runs of foreign crude	120,567	104,946	115,293	103,851	106,437	117,134	132,518	142,149	138,113	134,569	139,072	139,763	1,494,412
Exports [3]	836	942	349	19	--	--	--	--	--	--	--	--	2,146
Transfers:													
Distillate	53	48	49	59	61	43	47	47	49	43	43	45	587
Residual	371	371	341	391	451	451	559	399	682	482	623	495	5,616
Losses	411	370	399	384	401	403	430	434	418	413	410	426	4,899
Total disposition by use	382,864	341,508	370,194	354,957	372,394	373,399	401,412	405,313	389,493	384,267	381,755	397,118	4,554,674

p Preliminary except for crude petroleum production.
[1] Reported to the Bureau of Mines. Imports of crude oil include some Athabasca hydrocarbons.
[2] Represents the difference between supply and indicated demand for crude petroleum.
[3] U.S. Department of Commerce.

Table 18.—Input and output of petroleum products at refineries in the United States

(Thousand barrels)

	1971	1972	1973	1974	1975 p
INPUT					
Crude petroleum:					
Domestic	3,481,543	3,473,880	3,359,946	3,168,596	3,047,014
Foreign [1]	606,266	806,983	1,177,308	1,260,130	1,494,412
Total crude petroleum	4,087,809	4,280,862	4,537,254	4,428,726	4,541,426
Unfinished oils rerun (net)	+43,608	51,518	+45,768	+37,351	+12,664
Total crude and unfinished oils rerun	4,131,417	4,332,381	4,583,022	4,466,077	4,554,090
Natural gas liquids:					
Liquefied petroleum gases	79,695	85,193	80,221	80,217	89,662
Natural gasoline	166,222	164,062	160,350	147,603	134,087
Plant condensate	39,020	53,190	56,911	44,596	35,570
Total natural gas liquids	284,937	302,445	297,482	272,416	259,319
Other hydrocarbons and hydrogen [2]	6,074	10,118	10,716	13,057	13,779
OUTPUT					
Gasoline:					
Motor gasoline [3]	2,179,093	2,298,775	2,382,418	2,320,488	2,378,960
Aviation gasoline	18,457	16,993	16,413	15,895	13,718
Total gasoline [3]	2,197,550	2,315,768	2,398,831	2,336,383	2,392,678
Jet fuel:					
Naphtha-type [3]	85,317	76,565	65,997	71,175	65,620
Kerosine-type	219,348	233,464	247,692	233,889	252,361
Total jet fuel [3]	304,665	310,029	313,689	305,064	317,981
Ethane (including ethylene)	9,266	9,197	9,194	6,330	4,055
Liquefied refinery gas:					
For fuel use	88,648	84,514	89,570	81,561	80,514
For chemical use	32,304	36,668	38,062	35,433	28,819
Total liquefied refinery gas	120,952	121,182	127,632	116,994	109,333
Kerosine [3]	86,256	79,027	79,422	56,646	55,495
Distillate fuel oil [3]	910,727	962,405	1,029,343	973,764	968,436
Residual fuel oil	274,684	292,519	354,597	390,491	450,957
Petrochemical feedstocks:					
Still gas	16,158	14,678	12,428	14,375	15,723
Naphtha-400°	54,096	57,027	57,155	62,568	54,770
Other	40,694	52,321	62,981	57,821	51,694
Total petrochemical feedstocks	110,948	124,026	132,564	134,764	122,187
Special naphthas [3]	28,255	32,096	32,873	33,362	27,200
Lubricants	65,473	65,349	68,742	70,694	56,221
Wax (280 pounds=1 barrel)	6,939	6,148	6,768	6,929	5,665
Coke (1 short ton=5.0 barrels)	109,114	119,765	132,290	123,746	129,241
Asphalt (1 short ton=5.5 barrels)	157,039	155,294	167,884	164,237	143,957
Road oil	8,755	7,943	7,326	7,162	4,944
Still gas for fuel	156,967	170,993	176,758	175,724	175,351
Miscellaneous [3]	14,271	15,364	18,795	24,515	31,269
Processing gain (−) or loss (+)	−139,433	−142,161	−165,488	−175,255	−167,782

p Preliminary.
[1] Includes some Athabasca hydrocarbons.
[2] "Other hydrocarbons and hydrogen" is defined as including all hydrogen, process natural gas, tar sand bitumen, gilsonite, shale oil, and other naturally occurring hydrocarbon mixtures consumed as raw materials in the production of finished products.
[3] Production at gas-processing plants shown as direct transfers and omitted from the input and output at refineries.

Table 19.—Input and output at refineries in the United States, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
INPUT 1974													
Crude petroleum:													
Domestic	277,845	247,059	275,625	261,931	268,734	264,162	269,877	269,506	253,147	258,750	253,353	268,607	3,168,596
Foreign [1]	78,361	63,804	76,383	92,758	113,597	116,750	127,265	122,472	110,564	122,104	116,595	119,477	1,260,130
Total crude petroleum	356,206	310,863	352,008	354,689	382,331	380,912	397,142	391,978	363,711	380,854	369,948	388,084	4,428,726
Unfinished oils rerun (net)	+4,924	+6,100	−6,721	+3,803	−683	+1,662	+5,798	+7,303	+5,125	+1,852	+2,843	+5,345	+37,351
Total crude and unfinished oils rerun	361,130	316,963	345,287	358,492	381,648	382,574	402,940	399,281	368,836	382,706	372,791	393,429	4,466,077
Natural gas liquids:													
Liquefied petroleum gases	7,073	6,015	5,900	5,303	5,765	5,779	5,770	6,431	6,646	7,814	8,211	9,510	80,217
Natural gasoline	12,770	11,409	12,262	11,107	12,368	12,227	13,231	13,233	12,064	12,907	12,093	11,932	147,603
Plant condensate	4,765	4,326	4,158	4,302	2,898	3,519	3,408	3,325	3,439	3,697	3,539	3,220	44,596
Total natural gas liquids	24,608	21,750	22,320	20,712	21,031	21,525	22,409	22,989	22,149	24,418	23,843	24,662	272,416
Other hydrocarbons	977	1,123	751	1,200	1,174	1,203	1,246	1,505	1,005	903	994	976	13,057
OUTPUT 1974													
Gasoline:													
Motor gasoline [2]	182,900	167,140	185,443	189,329	196,186	199,892	210,573	211,259	193,590	196,427	188,751	198,998	2,320,488
Aviation gasoline	1,120	973	1,010	1,075	1,477	1,444	1,567	1,684	1,934	1,301	1,290	1,020	15,895
Total gasoline [2]	184,020	168,113	186,453	190,404	197,663	201,336	212,140	212,943	195,524	197,728	190,041	200,018	2,336,383
Jet fuel:													
Naphtha-type [2]	5,453	4,859	6,661	6,128	6,850	6,427	5,183	5,162	6,482	6,118	6,497	5,355	71,175
Kerosine-type	19,341	17,066	19,122	19,919	20,059	17,869	19,678	19,790	19,533	20,783	19,388	21,341	233,889
Total jet fuel [2]	24,794	21,925	25,783	26,047	26,909	24,296	24,861	24,952	26,015	26,901	25,885	26,696	305,064
Ethane (including ethylene)	673	684	715	459	477	447	486	492	456	533	457	451	6,330
Liquefied gases:													
LRG for fuel use	6,497	5,878	6,561	7,229	7,539	7,322	7,586	7,381	6,819	6,479	6,006	6,264	81,561
LRG for chemical use	2,956	2,875	3,280	2,902	2,514	3,280	3,222	3,320	3,167	3,204	2,556	2,157	35,433
Total liquefied gases	9,453	8,753	9,841	10,131	10,053	10,602	10,808	10,701	9,986	9,683	8,562	8,421	116,994
Kerosine [2]	5,900	5,595	4,651	3,591	3,897	4,038	3,695	4,088	4,099	5,788	5,342	5,962	56,646
Distillate fuel oil [2]	89,287	67,166	69,014	75,655	83,838	83,485	86,547	83,852	76,546	83,696	84,019	90,659	973,764
Residual fuel oil	33,222	28,808	28,259	29,539	30,835	30,773	32,727	33,072	30,963	34,060	36,861	41,372	390,491
Petrochemical feedstocks:													
Still gas	1,263	877	799	795	889	1,232	1,184	1,308	1,298	1,464	1,246	2,020	14,375
Naphtha-400°	4,728	4,921	5,189	4,409	4,954	5,258	6,263	5,948	5,250	5,269	5,330	5,049	62,568
Other	4,176	4,675	4,242	4,192	4,176	4,660	5,567	5,447	5,087	5,301	5,363	4,935	57,821

See footnotes at end of table.

Table 19.—Input and output at refineries in the United States, by month—Continued

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Petrochemical feedstocks—Continued													
Total petrochemical feedstocks	10,167	10,473	10,230	9,396	10,019	11,150	13,014	12,703	11,635	12,034	11,939	12,004	134,764
Special naphthas [2]	2,809	2,529	2,795	2,891	2,968	2,604	2,928	2,937	2,701	2,911	2,818	2,471	33,362
Lubricants:													
Bright stock	621	517	605	610	694	537	474	648	624	684	576	614	7,204
Neutral	2,661	2,319	2,757	2,586	2,570	2,695	2,621	2,676	2,670	2,592	2,676	2,540	31,363
Other grades	2,591	2,356	2,745	2,817	2,810	2,854	2,882	2,690	2,500	2,665	2,554	2,663	32,127
Total lubricants	5,873	5,192	6,107	6,013	6,074	6,086	5,977	6,014	5,794	5,941	5,806	5,817	70,694
Wax (280 pounds=1 barrel)													
Microcrystalline	90	90	103	103	105	93	95	98	84	104	82	89	1,136
Crystalline-fully refined	298	235	296	248	263	262	237	293	235	231	217	217	3,032
Crystalline-other	181	190	195	241	235	284	275	289	221	247	216	187	2,761
Total wax	569	515	594	592	603	639	607	680	540	582	515	493	6,929
Coke (1 short ton=5.0 barrels)	10,263	9,221	9,970	10,047	10,729	10,453	10,861	10,847	10,190	10,332	9,875	10,958	123,746
Asphalt (1 short ton=5.5 barrels)	8,802	8,668	11,504	13,058	14,696	16,135	17,622	17,286	15,626	16,786	13,266	10,788	164,237
Road oil	234	334	543	591	707	835	1,070	1,016	706	559	278	289	7,162
Still gas for fuel	13,833	12,543	13,285	14,472	14,835	15,616	16,869	16,545	14,220	14,981	14,217	14,308	175,724
Miscellaneous products [2]	1,669	1,426	1,566	1,862	2,393	2,156	2,413	2,303	1,890	2,215	2,264	2,358	24,515
Processing gain (—) or loss (+)	—14,853	—12,109	—12,952	—14,344	—12,843	—15,349	—16,030	—16,656	—14,901	—16,703	—14,517	—13,998	—175,255
INPUT 1975 [p]													
Crude petroleum:													
Domestic	260,626	234,831	253,763	250,253	265,044	255,368	267,858	262,284	250,231	248,760	241,607	256,389	3,047,014
Foreign [1]	120,567	104,946	115,293	103,851	106,437	117,134	132,518	142,149	138,113	134,569	139,072	139,763	1,494,412
Total crude petroleum	381,193	339,777	369,056	354,104	371,481	372,502	400,376	404,433	388,344	383,329	380,679	396,152	4,541,426
Unfinished oils rerun (net)	+9,464	—371	—2,833	—2,909	—6,010	+3,608	+4,379	—1,113	+4,201	+2,259	—1,604	+3,593	+12,664
Total crude and unfinished oils rerun	390,657	339,406	366,223	351,195	365,471	376,110	404,755	403,320	392,545	385,588	379,075	399,745	4,554,090
Natural gas liquids:													
Liquefied petroleum gases	9,431	7,732	7,658	5,991	5,637	5,483	6,283	6,266	7,220	8,105	9,390	10,466	89,662
Natural gasoline	10,640	10,279	11,395	10,824	11,200	11,178	12,051	12,049	10,975	11,891	10,814	10,791	134,087
Plant condensate	3,371	2,542	3,608	3,204	2,637	3,123	3,394	3,082	2,888	2,594	2,578	2,549	35,570
Total natural gas liquids	23,442	20,553	22,661	20,019	19,474	19,784	21,728	21,397	21,083	22,590	22,782	23,806	259,319
Other hydrocarbons and hydrogen	946	850	775	1,110	1,128	1,214	1,498	1,326	1,116	1,303	1,349	1,164	13,779

OUTPUT 1975 p													
Gasoline:													
Motor gasoline [2]	201,768	175,727	188,167	181,377	189,918	200,082	217,088	213,024	204,675	198,697	198,070	210,367	2,378,960
Aviation gasoline	1,110	910	923	884	1,107	1,052	1,330	1,482	1,264	1,524	1,294	838	13,718
Total gasoline [2]	202,878	176,637	189,090	182,261	191,025	201,134	218,418	214,506	205,939	200,221	199,364	211,205	2,392,678
Jet fuel:													
Naphtha-type [2]	4,294	4,651	6,157	4,967	5,672	4,901	5,820	5,812	5,735	6,082	6,047	5,482	65,620
Kerosine-type	21,475	18,723	21,633	20,939	21,016	20,264	21,561	23,884	21,487	20,689	19,866	20,824	252,361
Total jet fuel	25,769	23,374	27,790	25,906	26,688	25,165	27,381	29,696	27,222	26,771	25,913	26,306	317,981
Ethane (including ethylene)	422	305	278	326	336	355	319	359	329	321	352	353	4,055
Liquefied refinery gases:													
For fuel use	7,063	6,085	6,221	6,123	6,815	6,578	7,295	7,749	6,635	6,867	6,393	6,690	80,514
For chemical use	2,043	1,886	2,174	1,735	2,115	2,768	2,811	2,959	2,811	2,425	2,520	2,572	28,819
Total liquefied refinery gases	9,106	7,971	8,395	7,858	8,930	9,346	10,106	10,708	9,446	9,292	8,913	9,262	109,333
Kerosine [2]	6,101	5,715	4,878	4,462	4,217	2,790	3,697	4,342	4,344	4,426	4,719	5,804	55,495
Distillate fuel oil [2]	88,418	75,005	78,480	74,595	75,366	77,216	80,282	80,346	84,358	85,083	83,004	86,283	968,436
Residual fuel oil	43,857	37,912	40,260	37,335	35,678	34,569	35,798	35,522	35,500	36,130	36,426	41,970	450,957
Petrochemical feedstocks:													
Still gas	1,313	1,145	1,077	1,155	1,070	1,298	1,379	1,430	1,309	1,482	1,704	1,361	15,723
Naphtha-400°	4,790	3,418	4,259	3,932	3,760	4,346	4,632	4,733	5,418	5,076	5,372	5,034	54,770
Other	4,661	3,011	4,139	3,177	3,344	3,912	4,611	5,144	4,811	4,811	4,730	5,343	51,694
Total petrochemical feedstocks	10,764	7,574	9,475	8,264	8,174	9,556	10,622	11,307	11,538	11,369	11,806	11,738	122,187
Special naphthas [2]	2,084	1,990	2,117	1,897	2,339	2,140	2,368	2,128	2,558	2,333	2,552	2,694	27,200
Lubricants:													
Bright stock	637	443	497	468	550	539	542	572	524	627	648	500	6,547
Neutral	2,274	1,468	2,205	1,983	1,995	2,211	2,296	2,152	2,508	2,518	2,417	2,487	26,514
Other grades	1,950	1,743	1,941	1,953	1,980	1,882	1,957	1,948	1,818	1,933	1,926	2,129	23,160
Total lubricants	4,861	3,654	4,643	4,404	4,525	4,632	4,795	4,672	4,850	5,078	4,991	5,116	56.221
Wax (280 pounds=1 barrel)													
Microcrystalline	89	43	58	73	75	61	83	96	89	98	84	83	932
Crystalline-fully refined	152	102	124	158	188	181	234	233	198	252	270	246	2,338
Crystalline-other	217	135	133	193	173	198	213	200	200	258	265	210	2,395
Total wax	458	280	315	424	436	440	530	529	487	608	619	539	5,665
Coke (1 short ton=5.0 barrels)	10,892	9,825	10,523	10,215	10,155	10,698	11,295	10,990	11,102	11,537	10,577	11,432	129,241
Asphalt (1 short ton=5.5 barrels)	8,184	7,516	9,220	9,410	13,119	14,448	16,613	16,202	14,827	14,466	11,629	8,323	143,957
Road oil	414	229	263	264	407	884	615	552	381	297	401	237	4,944
Still gas for fuel	14,798	12,919	14,312	13,674	14,822	14,536	16,264	15,743	14,871	14,273	13,860	15,279	175,351
Miscellaneous products [2]	2,123	2,175	2,663	2,463	2,624	2,169	2,243	2,253	2,833	3,181	2,919	8,623	31,269
Processing gain (−) or loss (+)	−16,084	−12,272	−13,043	−11,434	−12,768	−12,970	−13,365	−13,812	−15,841	−15,905	−14,839	−15,449	−167,782

p Preliminary.
[1] Includes some Athabasca hydrocarbons.
[2] Production at gas-processing plants shown as direct transfers and omitted from the input and output at refineries.

Table 20.—Input and output at refineries

(Thousand

	District I			District II			
	East coast	Appalachian No. 1	Total	Appalachian No. 2	Ind., Ill., etc.	Minn., Wisc., etc.	Okla., Kans., etc.
INPUT 1974							
Crude petroleum:							
Domestic	61,851	24,231	86,082	13,467	610,850	21,190	323,251
Foreign [1]	392,802	35,297	428,099	7,378	[1] 170,739	59,998	9,665
Total crude petroleum	454,653	59,528	514,181	20,845	781,589	81,188	332,916
Unfinished oils rerun (net)	+32,510	+653	+33,163	+743	−2,489	−69	+188
Total crude and unfinished oils rerun	487,163	60,181	547,344	21,588	779,100	81,119	333,104
Natural gas liquids:							
Liquefied petroleum gases	248	128	376	713	16,230	2,406	11,810
Natural gasoline	263	--	263	--	5,238	3,548	12,762
Plant condensate	825	2,505	3,330	221	10,343	4,546	30
Total natural gas liquids	1,336	2,633	3,969	934	31,811	10,500	24,602
Other hydrocarbons and hydrogen	901	--	901	--	711	--	288
OUTPUT 1974							
Gasoline:							
Motor gasoline [2]	231,464	24,578	256,042	12,604	448,346	48,637	199,738
Aviation gasoline	264	--	264	--	1,829	--	459
Total gasoline [2]	231,728	24,578	256,306	12,604	450,175	48,637	200,197
Jet fuel							
Naphtha-type	2,677	620	3,297	--	7,080	1,023	6,994
Kerosine-type	9,267	510	10,137	--	34,872	1,622	9,277
Total jet fuel	12,304	1,130	13,434	--	41,952	2,645	16,271
Ethane (including ethylene)	17	--	17	--	76	--	442
Liquefied gases:							
For fuel use	10,290	1,010	11,300	448	15,176	1,514	5,995
For chemical use	5,712	--	5,712	--	3,108	--	790
Total liquefied gases	16,002	1,010	17,012	448	18,284	1,514	6,785
Kerosine [2]	3,691	1,591	5,282	704	12,120	195	828
Distillate fuel oil [2]	120,524	15,454	135,978	4,731	167,594	22,460	85,995
Residual fuel oil	49,059	7,105	56,164	2,093	48,612	6,595	8,475
Petrochemical feedstocks:							
Still gas	792	62	854	--	2,664	--	89
Naphtha-400°	5,456	--	5,456	--	3,777	--	1,052
Other	482	742	1,224	--	1,954	--	188
Total petrochemical feedstocks	6,730	804	7,534	--	8,395	--	1,329
Special naphthas [2]	27	205	232	245	4,501	--	2,473
Lubricants:							
Bright stock	719	1,388	2,107	--	341	--	733
Neutral	2,502	2,833	5,335	--	3,051	--	3,031
Other grades	4,265	391	4,656	--	1,772	--	1,731
Total lubricants	7,486	4,612	12,098	--	5,164	--	5,495
Wax (280 pounds=1 barrel):							
Microcrystalline	78	142	220	--	--	--	296
Crystalline-fully refined	362	70	432	--	232	--	261
Crystalline-other	18	390	408	--	184	--	437
Total wax	458	602	1,060	--	416	--	994
Wax (280 pounds=1 barrel):							
Coke (1 short ton=5.0 barrels)	11,607	395	12,002	349	22,747	2,572	10,661
Asphalt (1 short ton=5.5 barrels)	32,372	1,491	33,863	1,366	33,696	5,948	14,770
Road oil	--	355	355	--	3,106	91	872
Still gas for fuel	17,390	1,867	19,257	484	30,115	2,432	11,417
Miscellaneous	2,483	2,270	4,753	70	1,853	9	816
Processing gain (−) or loss (+)	−22,478	−655	−23,133	−572	−37,184	−1,479	−9,826
INPUT 1975 p							
Crude petroleum:							
Domestic	31,968	28,677	60,645	8,304	600,205	23,065	331,051
Foreign [1]	424,287	28,871	453,158	12,593	195,369	63,932	11,033
Total crude petroleum	456,255	57,548	513,803	20,897	795,574	86,997	342,084

See footnotes at end of table.

in the United States, by PAD district

barrels)

	District III								
Total	Texas inland	Texas gulf	La. gulf	Ark., La. inland etc.	N. Mex.	Total	District IV (Other Rocky Mt.)	District V (West coast)	United States
968,758	149,839	813,067	533,895	56,392	22,417	1,575,610	137,175	400,971	3,168,596
247,780	3,594	221,624	61,422	269	--	286,909	16,268	281,074	[1] 1,260,130
1,216,538	153,433	1,034,691	595,317	56,661	22,417	1,862,519	153,443	682,045	4,428,726
−1,627	+893	−21,530	+18,107	+586	−1,162	−3,106	+1,049	+7,872	+37,351
1,214,911	154,326	1,013,161	613,424	57,247	21,255	1,859,413	154,492	689,917	4,466,077
31,159	5,819	12,396	18,191	965	592	37,963	3,607	7,112	80,217
21,548	15,729	80,872	17,766	1,272	994	116,633	1,945	7,214	147,603
15,140	512	9,178	1,325	3,428	--	14,443	9,171	2,512	44,596
67,847	22,060	102,446	37,282	5,665	1,586	169,039	14,723	16,838	272,416
999	144	554	4,995	548	6	6,247	315	4,595	13,057
709,325	92,926	510,439	314,749	22,701	9,820	950,635	81,998	322,488	2,320,488
2,288	1,996	4,536	2,220	--	--	8,752	464	4,127	15,895
711,613	94,922	514,975	316,969	22,701	9,820	959,387	82,462	326,615	2,336,383
15,097	6,632	8,733	9,811	1,891	2,092	29,159	4,302	19,320	71,175
45,771	7,617	53,453	52,692	3	72	113,837	4,841	59,303	233,889
60,868	14,249	62,186	62,503	1,894	2,164	142,996	9,143	78,623	305,064
518	96	3,813	1,375	--	--	5,284	--	511	6,330
23,133	3,229	16,390	11,198	1,142	389	32,348	1,780	13,000	81,561
3,898	290	17,543	3,860	260	4	21,957	88	3,778	35,433
27,031	3,519	33,933	15,058	1,402	393	54,305	1,868	16,778	116,994
13,847	1,088	20,054	10,950	778	774	33,644	874	2,999	56,646
280,780	30,479	244,144	137,236	12,664	4,870	429,393	45,426	82,187	973,764
65,775	8,573	78,607	33,386	8,599	2,837	132,002	12,396	124,154	390,491
2,753	300	9,516	777	--	--	10,593	121	54	14,375
4,829	3,308	40,030	2,116	329	--	45,783	--	6,500	62,568
2,142	3,468	22,680	26,577	295	--	53,020	--	1,435	57,821
9,724	7,076	72,226	29,470	624	--	109,396	121	7,989	134,764
7,219	1,275	16,971	152	1,898	1	20,297	108	5,506	33,362
1,074	--	2,122	560	--	--	2,682	45	1,296	7,204
6,082	--	9,755	6,391	874	--	17,020	291	2,635	31,363
3,503	8	19,671	1,326	1,288	--	22,293	86	1,589	32,127
10,659	8	31,548	8,277	2,162	--	41,995	422	5,520	70,694
296	87	162	27	329	--	605	14	1	1,136
493	--	526	886	--	--	1,412	68	627	3,032
621	--	931	95	--	--	1,026	29	677	2,761
1,410	87	1,619	1,008	329	--	3,043	111	1,305	6,929
36,329	3,454	22,403	13,036	743	202	39,838	3,854	31,723	123,746
55,780	7,205	9,673	14,579	8,974	907	41,338	9,887	23,369	164,237
4,069	24	--	--	21	--	45	536	2,157	7,162
44,448	5,399	37,322	30,478	1,480	656	75,335	5,642	31,042	175,724
2,748	1,518	5,531	7,519	130	3	14,701	72	2,241	24,515
−49,061	−2,442	−38,844	−26,295	−939	+220	−68,300	−3,392	−31,369	−175,255
962,625	152,375	752,994	498,068	55,903	29,039	1,488,379	139,003	396,362	3,047,014
282,927	5,258	299,739	125,781	671	--	431,449	16,392	310,486	1,494,412
1,245,552	157,633	1,052,733	623,849	56,574	29,039	1,919,828	155,395	706,848	4,541,426

Table 20.—Input and output at refineries in the

	District I			District II			
	East coast	Appalachian No. 1	Total	Appalachian No. 2	Ind., Ill., etc.	Minn., Wisc., etc.	Okla., Kans., etc.
Unfinished oils rerun (net)	19,055	295	19,350	474	−1,754	−48	−341
Total crude and unfinished oils rerun	475,310	57,843	533,153	21,371	793,820	86,949	341,743
Natural gas liquids:							
Liquefied petroleum gases	93	71	164	793	17,318	3,182	12,240
Natural gasoline	214	--	214	--	4,922	3,085	11,896
Plant condensate	131	2,909	3,040	--	7,844	2,611	560
Total natural gas liquids	438	2,980	3,418	793	30,084	8,878	24,696
Other hydrocarbons	994	--	994	--	766	14	212
OUTPUT 1975 p							
Gasoline:							
Motor gasoline [2]	225,079	22,943	248,022	12,506	459,883	52,260	207,435
Aviation gasoline	110	6	116	--	1,460	--	366
Total gasoline [2]	225,189	22,949	248,138	12,506	461,343	52,260	207,801
Jet fuel:							
Naphtha-type	1,922	522	2,444	--	6,762	1,257	6,064
Kerosine-type	13,099	527	13,626	--	36,639	1,804	9,263
Total jet fuel	15,021	1,049	16,070	--	43,401	3,061	15,327
Ethane (including ethylene)	40	--	40	--	--	--	352
Liquefied gases:							
For fuel use	10,396	964	11,360	377	15,190	1,977	6,034
For chemical use	3,992	44	4,036	--	2,960	--	635
Total liquefied gases	14,388	1,008	15,396	377	18,150	1,977	6,669
Kerosine [2]	3,501	1,638	5,139	626	11,810	234	1,035
Distillate fuel oil [2]	105,603	15,361	120,964	5,242	168,313	22,906	88,376
Residual fuel oil	61,962	6,272	68,234	1,700	50,723	6,852	10,415
Petrochemical feedstocks:							
Still gas	586	174	760	--	1,302	59	--
Naphtha-400°	5,602	--	5,602	--	2,865	--	663
Other	207	229	436	--	1,694	--	141
Total petrochemical feedstocks	6,395	403	6,798	--	5,861	59	804
Special naphthas [2]	163	142	305	150	3,689	--	2,170
Lubricants:							
Bright stock	582	1,414	1,996	--	171	--	508
Neutral	2,092	2,654	4,746	--	2,193	--	2,583
Other grades	2,701	283	2,984	--	1,293	--	1,639
Total lubricants	5,375	4,351	9,726	--	3,657	--	4,730
Wax (280 pounds=1 barrel):							
Microcrystalline	39	137	176	--	--	--	193
Crystalline-fully refined	304	26	330	--	209	--	200
Crystalline-other	--	397	397	--	99	--	592
Total wax	343	560	903	--	308	--	985
Coke (1 short ton=5.0 barrels)	13,306	257	13,563	253	23,996	3,059	11,606
Asphalt (1 short ton=5.5 barrels)	26,695	1,886	28,581	1,401	29,864	5,120	13,619
Road oil	--	--	--	--	2,432	83	509
Still gas for fuel	18,623	1,674	20,297	441	32,039	2,594	12,344
Miscellaneous	2,177	3,538	5,715	47	5,039	106	984
Processing gain (−) or loss (+)	−22,039	−265	−22,304	−579	−35,955	−2,470	−11,075

p Preliminary.
[1] Includes some Athabasca hydrocarbons.
[2] Production at gas-processing plants shown as direct transfers and omitted from the input and

United States, by PAD district—Continued

	District III						District IV (Other Rocky Mt.)	District V (West coast)	United States
Total	Texas inland	Texas gulf	La. gulf	Ark., La. inland etc.	N. Mex.	Total			
−1,669	2,474	−21,501	12,317	330	−2,753	−9,133	3,181	935	12,664
1,243,883	160,107	1,031,232	636,166	56,904	26,286	1,910,695	158,576	707,783	4,554,090
33,533	6,134	14,720	22,514	1,092	523	44,983	3,635	7,347	89,662
19,903	15,397	71,170	16,055	2,159	841	105,622	2,132	6,216	134,087
11,015	100	6,644	1,000	3,519	115	11,378	7,403	2,734	35,570
64,451	21,631	92,534	39,569	6,770	1,479	161,983	13,170	16,297	259,319
992	220	2,525	4,328	509	13	7,595	366	3,832	13,779
732,084	93,422	528,867	331,607	23,148	9,909	986,953	83,766	328,135	2,378,960
1,826	2,047	4,054	1,926	--	--	8,027	429	3,320	13,718
733,910	95,469	532,921	333,533	23,148	9,909	994,980	84,195	331,455	2,392,678
14,083	6,023	8,647	7,338	1,618	2,257	25,883	4,267	18,943	65,620
47,706	7,371	53,024	59,374	1	37	119,807	4,730	66,492	252,361
61,789	13,394	61,671	66,712	1,619	2,294	145,690	8,997	85,435	317,981
352	80	2,609	634	--	--	3,323	--	340	4,055
23,578	3,224	13,701	12,263	1,040	555	30,783	1,935	12,858	80,514
3,595	345	15,108	2,678	154	51	18,336	141	2,711	28,819
27,173	3,569	28,809	14,941	1,194	606	49,119	2,076	15,569	109,333
13,705	1,102	21,219	8,227	632	1,475	32,655	1,016	2,980	55,495
284,837	31,690	239,224	142,120	12,145	6,749	431,928	46,382	84,325	968,436
69,690	11,597	90,259	46,508	10,744	4,851	163,959	13,030	136,044	450,957
1,361	293	10,987	759	--	54	12,093	935	574	15,723
3,528	5,434	34,630	1,582	271	--	41,917	--	3,723	54,770
1,835	3,228	23,249	21,635	233	--	48,345	--	1,078	51,694
6,724	8,955	68,866	23,976	504	54	102,355	935	5,375	122,187
6,009	994	14,210	134	1,730	--	17,068	65	3,753	27,200
679	--	2,040	498	--	--	2,538	35	1,299	6,547
4,776	--	8,529	5,131	719	--	14,379	281	2,332	26,514
2,932	--	13,953	766	1,169	--	15,888	19	1,337	23,160
8,387	--	24,522	6,395	1,888	--	32,805	335	4,968	56,221
193	48	127	33	355	--	563	--	--	932
409	--	557	638	--	--	1,195	41	363	2,338
691	--	951	52	--	--	1,003	--	304	2,395
1,293	48	1,635	723	355	--	2,761	41	667	5,665
38,914	3,387	23,365	13,445	703	200	41,100	3,639	32,025	129,241
50,004	6,659	7,439	11,083	8,124	931	34,236	9,759	21,377	143,957
3,024	22	443	--	--	--	465	413	1,042	4,944
47,418	5,795	34,024	29,555	1,496	677	71,547	4,931	31,158	175,351
6,176	1,359	8,387	7,309	418	--	17,473	35	1,870	31,269
−50,079	−2,162	−33,312	−25,232	−517	32	−61,191	−3,737	−30,471	−167,782

output at refineries.

Table 21.—Percentage yields of refined petroleum products from crude oil in the United States [1]

Finished products	1971	1972	1973	1974	1975 p
Gasoline	46.2	46.2	45.6	45.9	46.5
Jet fuel	7.4	7.2	6.8	6.8	7.0
Ethane (including ethylene)	.2	.2	.2	.1	.1
Liquefied gases	2.9	2.8	2.8	2.6	2.4
Kerosine	2.1	1.8	1.7	1.3	1.2
Distillate fuel oil	22.0	22.2	22.5	21.8	21.3
Residual fuel oil	6.6	6.8	7.7	8.7	9.9
Petrochemical feedstocks	2.7	2.9	2.9	3.0	2.7
Special naphthas	.7	.7	.7	.8	.6
Lubricants	1.6	1.5	1.5	1.6	1.2
Wax	.2	.1	.2	.2	.1
Coke	2.6	2.8	2.9	2.8	2.8
Asphalt	3.8	3.6	3.6	3.7	3.2
Road oil	.2	.2	.2	.2	.1
Still gas	3.8	3.9	3.9	3.9	3.9
Miscellaneous	.4	.4	.4	.5	.7
Shortage	−3.4	−3.3	−3.6	−3.9	−3.7
Total	100.0	100.0	100.0	100.0	100.0

p Preliminary.
[1] Other unfinished oils added to crude in computing yields.

Table 22.—Salient statistics of the major refined petroleum products in the United States

(Thousand barrels)

Product	1972	1973	1974	1975 p
Isopentane:				
Production	7,251	5,828	3,794	3,759
Stocks at plants	99	32	16	6
Used at refineries	7,183	5,895	3,810	3,769
Natural gasoline:				
Production	156,450	155,880	144,129	130,065
Stocks, end of year:				
At plants	3,285	5,043	5,202	4,897
At refineries	1,418	1,085	1,262	1,314
Total stocks	4,703	6,128	6,464	6,211
Used at refineries	156,879	154,455	143,793	130,318
Plant condensate:				
Production	22,022	19,838	17,733	15,626
Stocks, end of year:				
At plants	763	739	507	617
At refineries	510	936	563	548
Total stocks	1,273	1,675	1,070	1,165
Imports	31,428	39,344	32,364	26,972
Used at refineries	53,190	56,911	44,596	35,570
Domestic demand	--	1,869	6,106	6,933
Finished gasoline:				
Production:				
At refineries	2,315,768	2,398,831	2,336,383	2,392,678
At gas-processing plants	4,182	3,029	1,084	959
Total gasoline production	2,319,950	2,401,860	2,337,467	2,393,637
Stocks, end of year:				
At refineries	217,025	213,334	221,817	237,949
At plants	124	83	64	53
Total stocks	217,149	213,417	221,881	238,002
Imports	24,787	48,759	74,402	67,249
Exports	656	1,664	1,013	850
Domestic demand	2,350,703	2,452,687	2,402,392	2,450,296
Motor gasoline:				
Production:				
At refineries	2,298,775	2,382,418	2,320,488	2,378,960
At gas-processing plants	4,182	3,029	1,084	959
Total motor gasoline production	2,302,957	2,385,447	2,321,572	2,379,919
Stocks, end of year:				
At refineries	212,770	209,395	218,346	234,925
At gas-processing plants	124	83	64	53
Total motor gasoline stocks	212,894	209,478	218,410	234,978

See footnotes at end of table.

Table 22.—Salient statistics of the major refined petroleum products in the United States —Continued

(Thousand barrels)

Product	1972	1973	1974	1975 p
Finished gasoline—Continued				
Motor gasoline—Continued				
Imports	24,787	48,759	74,402	67,249
Exports	424	1,466	865	744
Domestic demand	2,333,778	2,436,156	2,386,177	2,436,229
Aviation gasoline:				
Production	16,993	16,413	15,895	13,718
Stocks, end of year	4,255	3,939	3,471	3,024
Exports	232	198	148	106
Domestic demand	16,925	16,531	16,215	14,067
Jet fuel:				
Production	310,029	313,689	305,064	317,981
Stocks, end of year	25,493	28,544	29,435	30,380
Imports	71,174	77,557	59,396	48,523
Exports	957	1,568	969	610
Domestic demand	382,490	386,627	362,600	365,290
Naphtha-type:				
Production:				
At refineries	76,565	65,997	71,175	65,620
At gas-processing plants	--	--	--	--
Total production	76,565	65,997	71,175	65,620
Stocks, end of year:				
At refineries	6,147	5,599	5,529	5,222
At gas-processing plants	--	--	--	--
Total stocks	6,147	5,599	5,529	5,222
Imports	11,998	13,315	10,006	10,339
Exports	911	640	80	--
Domestic demand	88,495	79,220	81,171	76,543
Kerosine-type:				
Production	233,464	247,692	233,889	252,361
Stocks, end of year	19,346	22,945	23,906	25,158
Imports	59,176	64,242	49,390	38,184
Exports	46	928	889	610
Domestic demand	293,995	307,407	281,429	288,747
Ethane (including ethylene):				
Production:				
At gas-processing plants	100,691	108,220	117,791	122,945
At refineries	9,197	9,194	6,330	4,055
Total production	109,888	117,414	124,121	127,000
Stocks, end of year:				
At plants	7,052	5,023	4,562	7,014
At refineries	--	--	--	--
Total stocks	7,052	5,023	[1] 4,562	[1] 7,014
Domestic demand:				
Plant ethane	97,004	110,249	118,252	120,493
Refinery ethane and/or ethylene	9,197	9,194	6,330	4,055
Total domestic demand	106,201	119,443	124,582	124,548
Liquefied gases:				
Production:				
At gas-processing plants (LPG)	344,045	338,813	330,155	321,141
At refineries (LRG):				
For fuel use	84,514	89,570	81,561	80,514
For chemical use	36,668	38,062	35,433	28,819
Total production at refineries	121,182	127,632	116,994	109,333
Total production	465,227	466,445	447,149	430,474
Stocks, end of year:				
LPG stocks:				
At plants	67,807	83,086	97,956	105,557
At refineries	3,077	2,813	4,093	4,202
Total LPG stocks	70,884	85,899	102,049	109,759
LRG stocks:				
For fuel use	7,487	7,403	5,757	8,112
For chemical use	294	316	174	263
Total LRG stocks	7,781	7,719	5,931	8,375
Total stocks	78,665	93,618	[1] 107,980	[1] 118,134
Imports	32,401	48,002	44,971	40,727
Exports	11,469	9,955	9,038	9,488
LPG used at refineries	85,193	80,221	80,217	89,662

See footnotes at end of table.

Table 22.—Salient statistics of the major refined petroleum products in the United States —Continued

(Thousand barrels)

Product	1972	1973	1974	1975 p
Liquefied gases—Continued				
Domestic demand:				
LPG for fuel and chemical use	292,887	281,624	269,721	255,008
LRG for fuel use	84,019	89,654	83,207	78,159
LRG for chemical use	36,743	38,040	35,575	28,730
Total domestic demand	413,649	409,318	388,503	361,897
Propane (including propylene):				
Production:				
At gas-processing plants	218,039	212,886	206,539	200,573
At refineries:				
For fuel use	69,038	73,531	62,298	63,385
For chemical use	25,024	25,329	25,155	21,876
Total production at refineries	94,062	98,860	87,453	85,261
Total production	312,101	311,746	293,992	285,834
Stocks, end of year:				
Plant propane stocks:				
At plants	48,219	59,704	64,713	76,024
At refineries	190	357	97	92
Total plant propane stocks	48,409	60,061	64,810	76,116
Refinery propane and/or propylene stocks:				
For fuel use	4,959	4,399	3,684	5,527
For chemical use	193	187	112	200
Total refinery propane and/or propylene stocks	5,152	4,586	3,796	5,727
Total stocks	53,561	64,647	68,606	81,843
Imports	15,851	25,791	21,464	22,058
Exports	6,502	5,500	4,971	4,852
Plant propane used at refineries	3,934	2,755	3,465	3,926
Domestic demand:				
Plant propane	232,593	218,770	214,818	202,547
Refinery propane and/or propylene:				
For fuel use	69,129	74,091	63,013	61,542
For chemical use	25,094	25,335	25,230	21,788
Total refinery propane and/or propylene domestic demand	94,223	99,426	88,243	83,330
Total domestic demand	326,816	318,196	303,061	285,877
Butane (including butylene):				
Production:				
At gas-processing plants	88,924	88,766	87,171	85,018
At refineries:				
For fuel use	12,940	13,036	13,598	12,751
For chemical use	5,673	6,666	6,442	4,673
Total production at refineries	18,613	19,702	20,040	17,424
Total production	107,537	108,468	107,211	102,442
Stocks, end of year:				
Plant butane stocks:				
At plants	10,389	15,289	20,992	20,998
At refineries	1,425	1,369	2,212	2,325
Total plant butane stocks	11,814	16,658	23,204	23,323
Refinery butane and/or butylene stocks:				
For fuel use	2,161	2,471	2,014	2,520
For chemical use	15	16	39	47
Total refinery butane and/or butylene stocks	2,176	2,487	2,053	2,567
Total stocks	13,990	19,145	25,257	25,890
Imports	16,550	22,211	23,507	18,669
Exports	4,967	4,455	4,067	4,636
Plant butane used at refineries	44,512	39,327	45,599	48,576
Domestic demand:				
Plant butane	59,366	62,351	54,466	50,356

See footnotes at end of table.

Table 22.—Salient statistics of the major refined petroleum products in the United States —Continued

(Thousand barrels)

Product	1972	1973	1974	1975 p
Liquefied gases—Continued				
Butane (including butylene)—Continued				
Domestic demand—Continued				
Refinery butane and/or butylene:				
For fuel use	12,227	12,726	14,055	12,245
For chemical use	5,669	6,665	6,419	4,665
Total refinery butane and/or butylene	17,896	19,391	20,474	16,910
Total domestic demand	77,262	81,742	74,940	67,266
Butane-propane mixture:				
Production:				
At gas-processing plants	3,535	3,509	3,027	2,673
At refineries:				
For fuel use	2,536	3,003	5,665	4,378
For chemical use	3,892	3,491	655	51
Total production at refineries	6,428	6,494	6,320	4,429
Total production	9,963	10,003	9,347	7,102
Stocks, end of year:				
Plant butane-propane mixture:				
At plants	944	826	1,565	872
At refineries	31	128	26	14
Total plant butane-propane mixture stocks	975	954	1,591	886
Refinery butane-propane mixture:				
For fuel use	367	533	59	65
For chemical use	2	3	1	--
Total refinery butane-propane mixture stocks	369	536	60	65
Total stocks	1,344	1,490	1,651	951
Exports	--	--	--	--
Plant butane-propane mixture used at refineries	2,485	3,027	1,953	1,273
Domestic demand:				
Plant butane-propane mixture	928	503	437	2,105
Refinery butane-propane mixture:				
For fuel use	2,663	2,837	6,139	4,372
For chemical use	3,893	3,490	657	52
Total refinery butane-propane mixture	6,556	6.327	6,796	4,424
Total domestic demand	7,484	6,830	7,233	6,529
Isobutane:				
Production:				
At gas-processing plants	33,547	33,652	33,418	32,877
At refineries	2,079	2,576	3,181	2,219
Total production	35.626	36,228	36,599	35,096
Stocks, end of year:				
Plant isobutane:				
At plants	8,255	7,267	10,686	7,663
At refineries	1,431	959	1,758	1,771
Total plant isobutane stocks	9,686	8,226	12,444	9,434
Refinery isobutane	84	110	22	16
Total stocks	9,770	8,336	12,466	9,450
Plant isobutane used at refineries	34,262	35,112	29,200	35,887
Domestic demand: Refinery isobutane for chemical use	2,087	2,550	3,269	2,225
Kerosine (including range oil):				
Production:				
At refineries	79,027	79,422	56,646	55,495
At gas-processing plants	1,063	704	245	178
Total production	80,090	80,126	56,891	55,673
Stocks, end of year:				
At refineries	19,068	20,985	15,252	15,556
At plants	43	37	17	15
Total stocks	19,111	21,022	15,269	15,571
Imports	526	785	1,744	1,073
Exports	91	85	36	52
Domestic demand	85,852	78,915	64,352	57,990

See footnotes at end of table.

Table 22.—Salient statistics of the major refined petroleum products in the United States —Continued

(Thousand barrels)

Product	1972	1973	1974	1975 p
Distillate fuel oil:				
Production:				
At refineries	962,405	1,029,343	973,764	968,436
At gas-processing plants	1,220	835	261	214
Total production	963,625	1,030,178	974,025	968,650
Crude used directly as distillate	944	760	774	587
Stocks, end of year:				
At refineries	[2] 154,284	[2] 196,421	[2] 200,029	[2] 208,787
At plants	35	40	39	46
Total stocks	154,319	196,461	200,068	208,833
Imports	66,449	143,149	105,579	55,948
Exports	1,211	3,231	855	267
Domestic demand	1,066,110	1,128,714	1,075,916	1,039,841
Residual fuel oil:				
Production	292,519	354,597	390,491	450,957
Crude used directly as residual	3,322	6,126	4,751	5,616
Stocks, end of year	55,216	53,480	59,694	74,126
Imports	[4] 637,401	[4] 676,225	[4] 579,157	[4] 435,919
Exports	12,060	8,507	4,969	5,342
Domestic demand	925,647	1,030,177	963,216	887,963
Petrochemical feedstocks (excluding LRG): [3]				
Production	124,026	132,564	134,764	122,187
Stocks, end of year	2,766	2,387	3,486	2,924
Imports	3,178	3,825	4,364	2,061
Exports	4,627	6,839	5,561	8,037
Domestic demand:				
Still gas	14,678	12,428	14,375	15,723
Naphtha-400°	58,075	56,822	61,879	53,512
Other	50,944	60,679	56,214	47,538
Total domestic demand	123,697	129,929	132,468	116,773
Special naphthas:				
Production:				
At refineries	32,096	32,873	33,362	27,200
At gas-processing plants	264	210	175	125
Total production	32,360	33,083	33,537	27,325
Stocks, end of year:				
At refineries	5,224	4,514	5,716	4,373
At plants	8	7	4	4
Total stocks	5,232	4,521	5,720	4,377
Imports	863	88	938	43
Exports	1,509	1,652	1,300	1,221
Domestic demand	31,866	32,230	31,976	27,490
Lubricants:				
Production	65,349	68,742	70,694	56,221
Stocks, end of year	13,271	12,186	16,060	14,337
Imports	669	2,091	1,786	1,335
Exports:				
Grease	227	251	277	265
Oil	14,756	12,496	11,659	8,846
Total exports	14,983	12,747	11,936	9,111
Domestic demand	52,813	59,171	56,670	50,169
Wax (280 pounds=1 barrel):				
Production	6,148	6,768	6,929	5,665
Stocks, end of year	1,061	990	1,195	861
Imports	335	1,067	956	684
Exports	1,130	965	879	607
Domestic demand	5,409	6,941	6,801	6,076
Coke (1 short ton=5 barrels):				
Production:				
Marketable coke	66,814	67,527	63,950	66,500
Catalyst coke	52,951	64,763	59,796	62,741
Total production	119,765	132,290	123,746	129,241
Stocks, end of year	7,816	9,974	5,420	7,360
Exports	31,118	34,976	41,244	37,253
Domestic demand	88,276	95,156	87,056	90,048

See footnotes at end of table.

Table 22.—Salient statistics of the major refined petroleum products in the United States—Continued

(Thousand barrels)

Product	1972	1973	1974	1975 p
Asphalt (1 short ton=5.5 barrels):				
Production	155,294	167,884	164,237	143,957
Stocks, end of year	21,638	15,024	21,370	22,794
Imports	9,263	8,444	11,252	4,956
Exports	333	340	410	320
Domestic demand	163,788	182,602	168,733	147,384
Road oil:				
Production	7,943	7,326	7,162	4,944
Stocks, end of year	1,305	799	1,080	571
Domestic demand	7,538	7,832	6,881	5,453
Still gas for fuel: Production	179,993	176,758	175,724	175,351
Miscellaneous products: Production:				
At refineries	15,364	18,795	24,515	31,269
At gas-processing plants	1,028	1,066	731	946
Total production	16,392	19,861	25,246	32,215
Stocks, end of year:				
At refineries	1,632	1,378	1,815	2,578
At plants	22	16	10	5
Total stocks	1,654	1,394	1,825	2,583
Imports	--	--	655	2,340
Exports	1,058	1,187	1,207	1,124
Domestic demand	15,284	18,934	24,263	32,674
Unfinished oils (net):				
Input (+), output (−)	+51,518	+45,768	+37,351	+12,664
Stocks, end of year	94,761	99,154	106,031	106,352
Imports	45,705	50,161	44,228	12,985

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[1] Includes underground stocks at plants and refineries, in thousands of barrels, as follows: At plants—ethane, 1974, 3,183; 1975, 5,549; propane, 1974, 57,186; 1975, 68,765; butane, 1974, 18,522; 1975, 17,778; butane-propane mixtures, 1974, 894; 1975, 1962; isobutane, 1974, 9,809; 1975, 6,891. At refineries (includes LRG)—propane, 1974, 3,730; 1975, 4,822; butane, 1974, 3,324; 1975, 2,417; butane-propane mixtures, 1974, none; 1975, 1; and isobutane, 1974, 507; 1975, 628.

[2] Includes No. 4 fuel oil, in thousands of barrels: 1972, 3,723; 1973, 3,449; 1974, 4,116; 1975, 5,035.

[3] Produced at petroleum refineries. Data for LRG petrochemical feedstocks are included with those for "Liquefied gases."

[4] Includes foreign crude oil to be burned as fuel, in thousands of barrels: 1972, 10,419; 1973, 19,105; 1974, 7,508; 1975, 13,559.

NOTE.—"Stocks at refineries" include stocks at refineries and bulk terminals operated by refining and products pipeline companies including pipeline fill, and stocks at independent bulk terminals. "Stocks at plants" include stocks at plants and terminals operated by natural gas processing companies and natural gas liquids stocks at terminals of pipeline companies, including pipeline fill.

Table 23.—Production (refinery output) and consumption of motor gasoline in the United States, by State

(Thousand barrels)

State	1973		1974		1975 p	
	Production	Consumption [1]	Production	Consumption [1]	Production	Consumption [1]
Alabama	1,184	45,260	528	44,349	736	45,672
Alaska	(2)	3,232	(2)	3,883	(2)	4,613
Arizona	32	28,853	--	27,328	1	28,380
Arkansas	7,332	27,997	7,443	27,433	7,156	28,230
California	r [2] 267,624	248,217	[2] 262,402	235,428	[2] 265,086	243,256
Colorado	7,128	32,449	8,420	30,999	9,324	32,350
Connecticut	--	32,365	--	31,602	--	32,180
Delaware	(3)	7,347	(3)	7,059	(3)	7,209
District of Columbia	--	6,175	--	5,725	--	5,805
Florida	--	104,265	--	100,124	--	103,467
Georgia	--	67,589	(3)	65,229	--	66,030
Hawaii	(2)	6,589	(2)	6,615	(2)	6,899
Idaho	--	11,469	--	10,900	--	11,487
Illinois	r 219,832	120,557	214,648	119,637	214,872	121,127
Indiana	91,899	68,273	80,022	65,216	79,000	65,781
Iowa	--	43,357	--	39,215	--	39,451
Kansas	r [4] 103,861	34,125	[4] 100,222	31,646	[4] 106,302	32,852
Kentucky	[5] 29,493	40,623	[5] 29,197	39,919	[5] 34,623	41,513
Louisiana	r 292,638	42,117	280,733	41,818	296,641	43,894
Maine	--	12,946	--	12,382	--	12,762
Maryland	--	44,104	--	42,606	--	43,926
Massachusetts	--	56,262	--	54,689	--	55,083
Michigan	20,509	113,999	19,543	108,694	19,404	110,244
Minnesota	36,768	51,320	34,959	48,431	38,381	49,180
Mississippi	r 48,183	29,530	48,746	28,461	50,222	28,299
Missouri	(4)	65,293	(4)	62,586	(4)	63,541
Montana	r 27,269	11,305	27,069	10,667	27,048	10,829
Nebraska	(4)	22,303	(4)	20,674	(4)	20,975
Nevada	--	9,471	(2)	9,110	(2)	9,750
New Hampshire	--	9,646	--	9,299	--	9,603
New Jersey	r 100,238	77,782	89,760	75,588	85,321	78,132
New Mexico	9,479	16,721	9,820	16,275	9,909	16,868
New York	17,534	150,080	14,749	142,806	13,458	142,504
North Carolina	(6)	68,429	(6)	67,150	(6)	68,206
North Dakota	[7] 15,038	10,404	[7] 13,678	9,793	[7] 13,879	10,317
Ohio	r 114,748	124,301	117,540	119,193	124,490	121,315
Oklahoma	r 93,983	41,176	99,516	39,893	101,133	41,505
Oregon	--	29,695	--	28,278	--	29,158
Pennsylvania	r [3] 144,029	116,064	[3] 138,363	114,616	[3] 136,996	109,489
Rhode Island	--	9,984	--	8,851	--	9,240
South Carolina	--	35,200	--	34,682	--	35,862
South Dakota	--	11,402	--	10,868	--	11,915
Tennessee	(5)	54,675	(5)	51,948	(5)	54,632
Texas	r 610,581	179,763	603,365	169,030	622,289	177,697
Utah	r 22,060	16,827	21,031	14,677	22,335	15,403
Vermont	--	5,872	--	5,603	--	5,720
Virginia	[6] 10,708	60,667	[6] 13,170	58,130	[6] 12,247	59,802
Washington	63,879	41,236	60,086	39,689	63,048	41,239
West Virginia	(6)	18,586	(6)	18,248	(6)	19,346
Wisconsin	(7)	52,790	(7)	51,084	(7)	52,319
Wyoming	r 26,389	7,244	25,478	7,011	25,059	7,596
Total	r 2,382,418	2,525,936	2,320,488	2,425,137	2,378,960	2,482,654

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[1] American Petroleum Institute data for 1973. U.S. Department of Transportation, Federal Highway Administration data for years 1974 and 1975.

[2] Alaska, Hawaii and Nevada (1974-1975) included with California.

[3] Delaware and Georgia (1974) included with Pennsylvania.

[4] Nebraska and Missouri included with Kansas.

[5] Tennessee included with Kentucky.

[6] North Carolina and West Virginia included with Virginia.

[7] Wisconsin included with North Dakota.

Table 24.—Salient statistics of motor gasoline in the United States, by month and refining district

(Thousand barrels)

	1974						1975 p					
	Production at refineries	Production at gas-processing plants	Imports	Exports	Total stocks, end of period [1]	Domestic demand	Production at refineries	Production at gas-processing plants	Imports	Exports	Total stocks, end of period [1]	Domestic demand
By month:												
January	182,900	178	5,047	126	217,542	179,935	201,768	73	8,115	17	242,340	192,382
February	167,140	75	5,163	18	219,105	170,797	175,727	80	4,784	266	251,974	170,691
March	185,443	84	6,960	225	220,347	191,020	188,167	86	4,645	26	248,749	196,097
April	189,329	88	7,790	41	223,805	193,708	181,377	84	3,989	38	232,619	201,542
May	196,186	83	7,754	10	218,711	209,107	189,918	86	4,398	14	213,997	213,010
June	199,892	82	6,324	11	217,421	207,577	200,082	79	5,304	22	207,155	212,285
July	210,573	86	6,562	21	218,889	215,732	217,088	83	6,475	39	212,504	218,258
August	211,259	83	7,849	172	219,004	218,904	213,024	70	7,184	13	215,512	217,257
September	193,590	63	6,056	15	227,070	191,628	204,675	80	8,077	5	226,478	201,861
October	196,427	92	5,303	17	220,797	208,078	198,697	79	6,417	32	221,532	210,107
November	188,751	81	5,224	13	218,444	196,396	198,070	74	4,180	27	232,139	191,690
December	198,998	89	4,370	196	218,410	203,295	210,367	85	3,681	245	234,978	211,049
Total	2,320,488	1,084	74,402	865	218,410	2,386,177	2,378,960	959	67,249	744	234,978	2,436,229
By refining district:												
East coast	231,464	--	64,176	3	53,657	790,780	225,079	--	59,917	2	57,188	808,049
Appalachian No. 1	24,578	--			4,984		22,943	--			5,672	
Appalachian No. 2	12,604	--			2,853		12,506	--			3,344	
Indiana, Illinois, Kentucky, etc.	448,346	--	451	5	37,365	810,951	459,883	--	1,285	2	42,583	833,642
Minnesota, Wisconsin, etc.	48,637	--			7,958		52,260	--			7,853	
Oklahoma, Kansas, etc.	199,738	--			19,338		207,435	--			22,609	
Texas inland	92,926	655			9,272		93,422	668			9,099	
Texas gulf coast	510,439	212			25,117		528,867	187			26,006	
Louisiana gulf coast	314,749	94	6,851	556	14,855	362,069	331,607	--	1,554	600	14,353	361.619
Arkansas, Louisiana inland, etc.	22,701	123			10,459		23,148	104			11,015	
New Mexico	9,820	--			851		9,909	--			834	
Rocky Mountain	81,998	--	322	--	7,482	76,430	83,766	--	22	--	7,141	77,665
West coast	322,488	--	2,602	301	24,219	345,947	328,135	--	4,471	140	27,281	355,254
Total	2,320,488	1,084	74,402	865	218,410	2,386,177	2,378,960	959	67,249	744	234,978	2,436,229

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[1] Includes stocks of gasoline at refineries.

Table 25.—Salient statistics of aviation gasoline in the United States, by month and refining district

(Thousand barrels)

	1974				1975 p			
	Production	Exports	Stocks, end of period	Domestic demand	Production	Exports	Stocks, end of period	Domestic demand
By month:								
January	1,120	9	3,785	1,265	1,110	9	3,602	978
February	973	3	3,885	870	910	4	3,462	1,046
March	1,010	6	3,234	1,655	923	3	3,345	1,037
April	1,075	9	3,024	1,276	884	5	3,048	1,176
May	1,477	8	3,168	1,325	1,107	8	3,031	1,116
June	1,444	7	3,094	1,511	1,052	11	2,859	1,213
July	1,567	15	3,273	1,373	1,330	9	2,737	1,443
August	1,684	65	3,057	1,835	1,482	6	2,863	1,350
September	1,934	4	3,646	1,341	1,264	5	2,757	1,365
October	1,301	5	3,347	1,595	1,524	10	2,922	1,349
November	1,290	8	3,457	1,172	1,294	5	3,140	1,071
December	1,020	9	3,471	997	838	31	3,024	923
Total	15,895	148	3,471	16,215	13,718	106	3,024	14,067
By refining district:								
East coast	264	9	529	3,379	110	27	393	3,210
Appalachian No. 1	--		84		6		45	
Appalachian No. 2	--		2		--		1	
Illinois, Indiana, Kentucky, etc	1,829	2	623	4,144	1,460	--	691	3,570
Minnesota, Wisconsin, North Dakota	--		91		--		102	
Oklahoma, Kansas, etc.	459		191		366		126	
Texas inland	1,996		186		2,047		238	
Texas gulf coast	4,536		578		4,054		431	
Louisiana gulf coast	2,220	73	427	3,973	1,926	23	402	3,287
Arkansas, Louisiana inland, etc	--		30		--		7	
New Mexico	--		8		--		14	
Rocky Mountain	464	--	49	630	429	--	40	599
West coast	4,127	64	673	4,089	3,320	56	534	3,401
Total	15,895	148	3,471	16,215	13,718	106	3,024	14,067

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Table 26.—Shipments of aviation fuels to PAD districts

(Thousand barrels)

Product and use	District I	District II	District III	District IV	District V	United States
1974						
Aviation gasoline:						
For commercial use:						
Airlines	552	461	116	13	221	1,363
Factory	31	60	31	2	45	169
General aviation	2,491	2,498	1,737	604	2,270	9,600
Total	3,074	3,019	1,884	619	2,536	11,132
For military use	852	1,000	1,415	144	1,584	4,995
Jet fuel:						
For commercial use:						
Kerosine-type:						
Airlines	94,679	[r]50,162	22,276	6,896	65,904	[r]239,917
Factory	1,157	[r]354	285	5	430	[r]2,231
General aviation	3,361	3,112	2,486	497	1,691	11,147
Total	99,197	53,628	25,047	7,398	68,025	253,295
Naphtha-type:						
Airlines	[r]1,504	103	[r]132	92	[r]1,649	[r]3,480
Factory	12	260	20	--	10	302
General aviation	101	103	87	7	60	358
Total	[r]1,617	466	[r]239	99	[r]1,719	[r]4,140
Total for commercial use	[r]100,814	54,094	[r]25,286	7,497	[r]69,744	[r]257,435
For military use:						
JP-4	[r]14,690	15,327	[r]14,617	3,032	[r]21,194	[r]68,860
JP-5	9,260	338	973	--	9,194	19,765
Other	131	8	187	--	1,940	2,266
Total [1]	[r]24,081	15,673	[r]15,777	3,032	[r]32,328	[r]90,891
For nonaviation use [p]	3,878	839	213	9	231	5,170
1975						
Aviation gasoline:						
For commercial use:						
Airlines	372	102	68	18	277	837
Factory	34	61	21	--	34	150
General aviation	2,502	2,723	1,703	514	2,013	9,455
Total	2,908	2,886	1,792	532	2,324	10,442
For military use	618	570	831	81	1,342	3,442
Jet fuel:						
For commercial use:						
Kerosine-type:						
Airlines	97,184	50,185	22,310	7,083	70,848	247,610
Factory	1,088	339	309	3	417	2,156
General aviation	3,865	3,175	2,568	352	1,413	11,373
Total	102,137	53,699	25,187	7,438	72,678	261,139
Naphtha-type:						
Airlines	5	126	110	36	32	309
Factory	40	164	--	--	25	229
General aviation	23	61	2	7	667	760
Total	68	351	112	43	724	1,298
Total for commercial use	102,205	54,050	25,299	7,481	73,402	262,437
For military use:						
JP-4	13,511	14,114	14,440	3,291	19,411	64,767
JP-5	9,673	117	1,476	--	7,455	18,721
Other	106	9	222	--	3,182	3,519
Total [2]	23,290	14,240	16,138	3,291	30,048	87,007
For nonaviation use [p]	3,729	686	198	4	307	4,924

[p] Preliminary. [r] Revised.

[1] Excludes direct imports by the military of naphtha-type jet fuel into PAD I, 6,318,000 barrels; PAD V, 1,664,000 barrels. Also excludes direct imports by the military of kerosine-type jet fuel into PAD I, 660,000 barrels; PAD V, 73,000 barrels.

[2] Excludes direct imports by the military of naphtha-type jet fuel into PAD I. 8,721,000 barrels; PAD V, 1,506,000 barrels. Also excludes direct imports by the military of kerosine-type jet fuel into PAD I, 100,000 barrels; PAD V, 44,000 barrels.

Definitions of terms used in this table:

Aviation gasoline—Any fuel in the gasoline boiling range for use in a piston-type aviation engine.

Jet fuel—Any fuel for use in an aviation turbine engine.

Airline—Sales to U.S. certificated air carriers, including air freight carriers, and international air carriers (if delivery is made in the United States), and to such other air carriers as supplemental or non-schedule carriers, air taxi, etc.

Factory—Direct sales to airframe and engine manufacturers. Does not include aviation fuels supplied to these accounts for the Defense Fuel Supply Center (DFSC).

General aviation—All nonmilitary sales which are not classified as airline or factory. Primarily made up of sales to distributors and airport dealers.

Military—Sales to Defense Fuel Supply Center and to other military agencies of the Government.

Nonaviation—Sales for use in turbine engines other than aviation turbine engines. Sales to electric utilities are included in this category.

Table 27.—Salient statistics of jet fuel in the United States, by month and refining district

(Thousand barrels)

	Production			Imports			Exports			Total stocks, end of period			Domestic demand		
	Naphtha-type	Kerosine-type	Total	Naphtha-type	Kerosine-type	Total	Naphtha-type	Kerosine-type	Total	Naphtha-type	Kerosine-type	Total	Naphtha-type	Kerosine-type	Total
1974															
By month:															
January	5,453	19,341	24,794	145	4,065	4,210	4	62	66	5,828	23,904	29,732	5,365	22,385	27,750
February	4,859	17,066	21,925	26	2,073	2,099	7	53	60	6,069	23,548	29,617	4,637	19,442	24,079
March	6,661	19,122	25,783	292	4,009	4,301	5	74	79	6,711	23,285	29,996	6,306	23,320	29,626
April	6,128	19,919	26,047	529	3,436	3,965	4	63	67	6,837	24,888	31,725	6,527	21,689	28,216
May	6,850	20,059	26,909	1,417	4,946	6,363	4	22	26	6,701	25,623	32,324	8,399	24,248	32,647
June	6,427	17,869	24,296	816	3,413	4,229	5	93	98	6,677	25,523	32,200	7,262	21,289	28,551
July	5,183	19,678	24,861	1,206	5,435	6,641	3	157	160	6,436	25,235	31,671	6,627	25,244	31,871
August	5,162	19,790	24,952	1,553	4,839	6,392	5	60	65	5,742	25,247	30,989	7,404	24,557	31,961
September	6,482	19,533	26,015	1,449	5,053	6,502	3	37	40	5,779	24,407	30,186	7,891	25,389	33,280
October	6,118	20,783	26,901	802	4,180	4,982	4	155	159	5,606	24,958	30,564	7,089	24,257	31,346
November	6,497	19,388	25,885	987	3,206	4,193	5	67	72	5,883	23,733	29,616	7,202	23,752	30,954
December	5,355	21,341	26,696	784	4,735	5,519	31	46	77	5,529	23,906	29,435	6,462	25,857	32,319
Total	71,175	233,889	305,064	10,006	49,390	59,396	80	889	969	5,529	23,906	29,435	81,171	281,429	362,600
By refining district:															
East coast	2,677	9,627	12,304	6,769	27,789	34,558	1	2	3	182	4,963	5,145	21,087	114,345	135,432
Appalachian No. 1	620	510	1,130							39	313	352			
Appalachian No. 2	--	--	--							49	179	228			
Indiana, Illinois, Kentucky, etc	7,080	34,872	41,952							574	3,409	3,983			
Minnesota, Wisconsin, North and South Dakota	1,023	1,622	2,645	--	1,575	1,575	--	--	--	164	787	951	14,908	55,010	69,918
Oklahoma, Kansas, Missouri, etc	6,994	9,277	16,271							742	1,105	1,847			
Texas inland	6,632	7,617	14,249							353	1,088	1,441			
Texas gulf coast	8,733	53,453	62,186							479	3,306	3,785			
Louisiana gulf coast	9,811	52,692	62,503	861	2,987	3,848	--	--	--	841	2,821	3,662	18,085	25,339	43,424
Arkansas, Louisiana inland, etc	1,891	3	1,894							220	245	465			
New Mexico	2,092	72	2,164							226	76	302			
Rocky Mountain	4,302	4,841	9,143	--	--	--	--	--	--	298	449	747	2,983	7,840	10,823
West coast	19,320	59,303	78,623	2,376	17,039	19,415	79	887	966	1,362	5,165	6,527	24,108	78,895	103,003
Total	71,175	233,889	305,064	10,006	49,390	59,396	80	889	969	5,529	23,906	29,435	81,171	281,429	362,600

Note: In the printed table, a brace groups several districts for imports, exports and domestic demand. Each grouped figure is printed once and covers all of the districts in its group.

1975 p															
By month:															
January	4,294	21,475	25,769	730	6,381	7,111	--	59	59	5,548	24,773	30,321	5,282	26,994	32,276
February	4,651	18,723	23,374	984	4,604	5,588	--	62	62	5,415	23,718	29,133	5,768	24,320	30,088
March	6,157	21,633	27,790	947	3,073	4,020	--	43	43	6,155	24,301	30,456	6,364	24,080	30,444
April	4,967	20,939	25,906	413	3,709	4,122	--	39	39	5,777	24,486	30,263	5,758	24,424	30,182
May	5,672	21,016	26,688	713	3,424	4,137	--	68	68	5,484	25,235	30,719	6,678	23,623	30,301
June	4,901	20,264	25,165	650	2,523	3,173	--	39	39	5,253	24,084	29,337	5,782	23,899	29,681
July	5,820	21,561	27,381	490	2,230	2,720	--	69	69	5,578	24,220	29,798	5,985	23,586	29,571
August	5,812	23,884	29,696	861	3,240	4,101	--	52	52	5,654	25,449	31,103	6,597	25,843	32,440
September	5,735	21,487	27,222	1,420	2,782	4,202	--	45	45	5,797	25,494	31,291	7,012	24,179	31,191
October	6,082	20,689	26,771	818	2,473	3,291	--	44	44	5,864	24,546	30,410	6,833	24,066	30,899
November	6,047	19,866	25,913	998	1,669	2,667	--	41	41	5,812	23,165	28,977	7,097	22,875	29,972
December	5,482	20.824	26.306	1,315	2,076	3,391	--	49	49	5.222	25.158	30.380	7,387	20,858	28,245
Total	65,620	252,361	317,981	10,339	38,184	48,523	--	610	610	5.222	25,158	30,380	76,543	288,747	365,290
By refining district:															
East coast	1,922	13,099	15,021	8,721	19,377	28,098	--	4	4	278	6,510	6,788	21,825	115,652	137,477
Appalachian No. 1	522	527	1,049												
Appalachian No. 2	--	--	--												
Indiana, Illinois, Kentucky, etc	6,762	36,639	43,401												
Minnesota, Wisconsin, North and South Dakota	1,257	1,804	3,061	--	769	769	--	1	1	1,482	5,626	7,108	14,308	54,250	68,558
Oklahoma, Kansas, Missouri, etc	6,064	9,263	15,327												
Texas inland	6,023	7,371	13,394												
Texas gulf coast	8,647	53,024	61,671												
Louisiana gulf coast	7,338	59,374	66,712	112	1,752	1,864	--	--	--	1,851	6,933	8,784	15,122	27,444	42,566
Arkansas, Louisiana inland, etc	1,618	1	1,619												
New Mexico	2,257	37	2,294												
Rocky Mountain	4,267	4,730	8,997	--	4	4	--	--	--	188	407	595	3,072	7,813	10,885
West coast	18,943	66,492	85,435	1,506	16,282	17,788	--	605	605	1,423	5,682	7,105	22,216	83,588	105,804
Total	65,620	252,361	317,981	10,339	38,184	48,523	--	610	610	5,222	25,158	30,380	76,543	288,747	365,290

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Table 28.—Salient statistics of ethane (including ethylene) in the United States, by month and refining district

(Thousand barrels)

	1974					1975 p				
	Production			Total stocks, end of period	Domestic demand	Production			Total stocks, end of period	Domestic demand
	At gas-processing plants	At refineries	Total			At gas-processing plants	At refineries	Total		
By month:										
January	9,456	673	10,129	4,747	10,405	10,634	422	11,056	4,709	10,909
February	9,003	684	9,687	4,451	9,983	9,438	305	9,743	4,969	9,483
March	10,784	715	11,499	4,533	11,417	10,448	278	10,726	5,390	10,305
April	9,725	459	10,184	4,644	10,073	9,860	326	10,186	5,619	9,957
May	9,945	477	10,422	5,185	9,881	10,231	336	10,567	6,130	10,056
June	9,441	447	9,888	5,424	9,649	9,732	355	10,087	7,080	9,137
July	9,554	486	10,040	5,423	10,041	10,246	319	10,565	7,330	10,315
August	9,659	492	10,151	5,319	10,255	10,227	359	10,586	7,317	10,599
September	9,168	456	9,624	5,088	9,855	9,736	329	10,065	6,778	10,604
October	10,344	533	10,877	4,945	11,020	10,703	321	11,024	6,389	11,413
November	10,112	457	10,569	4,560	10,954	10,614	352	10,966	6,725	10,630
December	10,600	451	11,051	4,562	11,049	11,076	353	11,429	7,014	11,140
Total	117,791	6,330	124,121	4,562	124,582	122,945	4,055	127,000	7,014	124,548
By refining district:										
East coast	--	17	17	--	1,686	2,084	40	2,124	--	3,866
Appalachian No. 1	1,669	--	1,669			1,742	--	1,742		
Appalachian No. 2	--	--	--	1,550	14,899	--	--	--	1,707	15,213
Indiana, Illinois, Kentucky, etc	7,252	76	7,328			6,609	--	6,609		
Minnesota, Wisconsin, etc	--	--	--			--	--	--		
Oklahoma, Kansas, etc	7,454	442	7,896			8,409	352	8,761		
Texas inland	42,680	96	42,776	3,009	107,244	45,813	80	45,893	5,306	103,867
Texas gulf coast	16,491	3,813	20,304			14,831	2,609	17,440		
Louisiana gulf coast	36,348	1,375	37,723			36,389	634	37,023		
Arkansas, Louisiana inland, etc	1,033	--	1,033			889	--	889		
New Mexico	4,622	--	4,622			4,919	--	4,919		
Rocky Mountain	242	--	242	3	242	1,260	--	1,260	1	1,262
West coast	--	511	511	--	511	--	340	340	--	340
Total	117,791	6,330	124,121	4,562	124,582	122,945	4,055	127,000	7,014	124,548

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Table 29.—Salient statistics of liquefied gases (excluding ethane) in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1974								1975 p							
	Refinery production	Yield (percent)	Production at gas-processing plants	Imports	Exports	LPG used at refineries	Total stocks, end of period	Domestic demand	Refinery production	Yield (percent)	Production at gas-processing plants	Imports	Exports	LPG used at refineries	Total stocks, end of period	Domestic demand
By month:																
January	9,453	2.6	28,149	6,381	840	7,073	85,332	44,356	9,106	2.3	27,398	5,538	925	9,431	98,062	41,604
February	8,753	2.8	26,018	4,790	604	6,015	84,049	34,225	7,971	2.3	25,267	3,237	847	7,732	93,509	32,449
March	9,841	2.9	29,201	3,716	725	5,900	88,372	31,810	8,395	2.3	28,251	2,962	989	7,658	91,738	32,732
April	10,131	2.8	27,798	3,389	683	5,303	94,803	28,901	7,858	2.2	26,857	3,053	870	5,991	95,775	26,870
May	10,053	2.7	28,157	3,633	710	5,765	104,168	26,003	8,930	2.5	26,745	1,179	784	5,637	105,539	20,669
June	10,602	2.8	26,723	3,594	701	5,779	111,204	27,403	9,346	2.5	26,107	2,776	667	5,483	117,033	20,585
July	10,808	2.7	27,043	2,637	844	5,770	118,982	26,096	10,106	2.5	26,932	3,042	713	6,283	123,914	26,203
August	10,701	2.7	27,301	2,567	753	6,431	125,392	26,975	10,708	2.6	27,598	2,533	741	6,266	131,152	26,594
September	9,986	2.7	26,331	2,296	816	6,646	126,169	30,374	9,446	2.4	25,291	3,622	708	7,220	134,845	26,738
October	9,683	2.5	28,083	3,381	797	7,814	123,987	34,718	9,292	2.4	27,056	4,308	768	8,105	134,183	32,445
November	8,562	2.3	27,383	3,518	744	8,211	117,831	36,664	8,913	2.4	26,275	3,900	654	9,390	131,358	31,869
December	8,421	2.2	27,968	5,069	821	9,510	107,980	40,978	9,262	2.3	27,364	4,577	822	10,466	118,134	43,139
Total	116,994	2.6	330,155	44,971	9,038	80,217	107,980	388,503	109,333	2.4	321,141	40,727	9,488	89,662	118,134	361,897
By refining district:																
East coast	16,002	3.3	5,945	5,958	31	248	4,111	57,725	14,388	3.0	7,594	6,716	22	93	5,434	65,766
Appalachian No. 1	1,010	1.7				128			1,008	1.8				71		
Appalachian No. 2	448	2.1				713			377	1.8				793		
Indiana, Illinois, Kentucky, etc	18,284	2.3	55,476	19,304	78	16,230	36,688	128,286	18,150	2.3	52,517	17,894	19	17,318	34,591	131,983
Minnesota, Wisconsin, etc	1,514	1.9				2,406			1,977	2.3				3,182		
Oklahoma, Kansas, etc	6,785	2.0				11,810			6,669	2.0				12,240		
Texas inland	3,519	2.3				5,819			3,569	2.2				6,134		
Texas gulf coast	33,933	3.3				12,396			28,809	2.8				14,720		
Louisiana gulf coast	15,058	2.4	252,199	9,566	7,327	18,191	64,559	172,766	14,941	2.2	244,689	5,386	7,755	22,514	75,195	134,623
Arkansas, Louisiana inland, etc	1,402	2.4				965			1,194	2.1				1,092		
New Mexico	393	1.9				592			606	2.3				523		
Rocky Mountain	1,868	1.2	11,440	5,535	--	3,607	830	9,431	2,076	1.3	11,770	5,706	--	3,635	716	11,402
West coast	16,778	2.4	5,095	4,608	1,602	7,112	1,792	20,295	15,569	2.2	4,571	5,025	1,692	7,347	2,198	18,123
Total	116,994	2.6	330,155	44,971	9,038	80,217	107,980	388,503	109,333	2.4	321,141	40,727	9,488	89,662	118,134	361,897

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Table 30.—Salient statistics of kerosine in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1974							1975 p						
	Production at refineries	Yield (percent)	Production at gas-processing plants	Imports	Exports	Total stocks, end of period	Domestic demand	Production at refineries	Yield (percent)	Production at gas-processing plants	Imports	Exports	Total stocks, end of period	Domestic demand
By month:														
January	5,900	1.6	42	182	3	17,486	9,657	6,101	1.6	16	299	3	16,466	6,814
February	5,595	1.8	29	365	--	15,609	7,866	5,715	1.6	13	234	2	15,348	7,078
March	4,651	1.3	30	232	3	15,001	5,518	4,878	1.3	19	107	--	15,170	5,182
April	3,591	1.0	27	158	5	14,873	3,899	4,462	1.3	19	--	12	15,255	4,384
May	3,897	1.0	26	--	7	16,579	2,210	4,217	1.2	16	42	1	16,512	3,017
June	4,038	1.0	12	130	2	17,315	3,442	2,790	.7	16	--	6	15,351	3,961
July	3,695	.9	12	41	4	17,195	3,864	3,697	.9	14	--	2	16,038	3,022
August	4,088	1.0	12	153	2	17,086	4,360	4,342	1.1	14	80	4	17,153	3,317
September	4,099	1.1	12	21	3	17,079	4,136	4,344	1.1	13	15	--	17,775	3,750
October	5,788	1.5	15	85	4	16,999	5,964	4,426	1.1	13	98	12	17,772	4,528
November	5,342	1.4	14	218	--	16,707	5,866	4,719	1.2	12	141	4	18,237	4,403
December	5,962	1.5	14	159	3	15,269	7,570	5,804	1.5	13	57	6	15,571	8,534
Total	56,646	1.3	245	1,744	36	15,269	64,352	55,495	1.2	178	1,073	52	15,571	57,990
By refining district:														
East coast	3,691	.8	--	1,453	8	6,439	27,199	3,501	.7	--	1,073	8	6,790	24,644
Appalachian No. 1	1,591	2.6	--			468		1,638	2.8	--			517	
Appalachian No. 2	704	3.3	--			317		626	2.9	--			294	
Indiana, Illinois, Kentucky, etc	12,120	1.6	--	--	2	3,004	18,738	11,810	1.5	--	--	2	3,014	16,195
Minnesota, Wisconsin, etc	195	.2	--			243		234	.3	--			185	
Oklahoma, Kansas, etc	828	.3	--			731		1,035	.3	--			478	
Texas inland	1,088	.7	154			239		1,102	.7	117			155	
Texas gulf coast	20,054	2.0	29			1,982		21,219	2.0	27			2,241	
Louisiana gulf coast	10,950	1.8	11	291	14	880	14,182	8,227	1.3	--	--	32	614	13,263
Arkansas, Louisiana inland, etc	778	1.4	--			409		632	1.1	1			621	
New Mexico	774	3.6	51			52		1,475	5.6	33			32	
Rocky Mountain	874	.6	--	--	--	169	1,165	1,016	.6	--	--	--	288	884
West coast	2,999	.4	--	--	12	336	3,068	2,980	.4	--	--	10	342	3,004
Total	56,646	1.3	245	1,744	36	15,269	64,352	55,495	1.2	178	1,073	52	15,571	57,990

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Table 31.—Sales of distillate fuel oil[1] in the United States in 1971–75, by use

(Million barrels)

Use	1971	1972	1973	1974	1975
Heating[2]	522.5	543.3	536.9	493.2	487.1
Industrial (excluding oil-company use)	50.7	60.4	67.3	64.0	64.0
Oil-company use	14.1	13.4	14.9	13.8	13.6
Electric utility companies	35.3	68.3	77.9	[3] 84.7	[4] 65.2
Railroads	86.2	97.0	102.8	103.0	93.2
Vessels	21.0	22.2	26.8	24.8	26.1
Military	17.4	20.2	19.6	17.8	18.0
On-highway diesel	167.0	189.1	221.4	221.0	217.2
Off-highway diesel	46.9	50.2	55.5	48.7	49.0
All other	10.2	10.8	11.9	10.1	10.1
Total	971.3	1,074.9	1,135.0	1,081.1	1,043.5

[1] Includes diesel fuel.
[2] Includes range oil.
[3] Includes 23.6 million barrels of distillate No. 2, 3.0 million barrels of distillate No. 4 fuel oil used at steam-electric plants, and 5.2 million barrels of kerosine-type jet fuel used by electric utility companies.
[4] Includes 19.7 million barrels of distillate No. 2, 2.5 million barrels of distillate No. 4 fuel oil used at steam-electric plants, and 3.2 million barrels of kerosine-type jet fuel used by electric utility companies.

Table 32.—Salient statistics of distillate fuel oil

(Thousand barrels

	1974						
	Production at refineries	Yield (percent)	Production at gas processing plants	Crude used directly as distillate [1]	Imports	Exports	Total stocks, end of period
By month:							
January	89,287	24.7	54	61	14,377	125	181,217
February	67,166	21.2	19	56	8,577	108	149,162
March	69,014	20.0	23	52	8,893	204	128,852
April	75,655	21.1	20	55	6,612	41	125,587
May	83,838	21.9	17	72	8,305	27	141,843
June	83,485	21.8	19	89	6,589	34	160,680
July	86,547	21.5	18	62	6,838	84	182,495
August	83,852	21.0	16	70	3,869	17	198,710
September	76,546	20.8	20	63	4,571	41	208,308
October	83,696	21.9	17	74	7,361	15	209,945
November	84,019	22.5	19	55	13,629	55	212,913
December	90,659	23.0	19	65	15,958	104	[2] 200,068
Total	973,764	21.8	261	774	105,579	855	[2] 200,068
By refining district:							
East coast	120,524	24.7	--	--	95,018	33	72,892
Appalachian No. 1	15,454	25.7	--				3,847
Appalachian No. 2	4,731	21.9	--				2,333
Indiana, Illinois, Kentucky, etc	167,594	21.5	--	283	621	5	30,367
Minnesota, Wisconsin, etc	22,460	27.7	--				9,432
Oklahoma, Kansas, etc	85,995	25.8	--				19,424
Texas inland	30,479	19.7	99				3,183
Texas gulf coast	244,144	24.1	47				23,590
Louisiana gulf coast	137,236	22.4	93	191	6,766	286	8,874
Arkansas, Louisiana inland, etc	12,664	22.1	22				7,482
New Mexico	4,870	22.9	--				347
Rocky Mountain	45,426	29.4	--	69	32	--	3,982
West coast	82,187	11.9	--	231	3,142	531	14,315
Total	973,764	21.8	261	774	105,579	855	[2] 200,068

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[1] Figures represent crude oil used as fuel on pipelines which si considered part of the demand for
[2] Includes No. 4 fuel oil in thousands of barrels: PAD district I, 1974, 3,622; 1975, 3,911; PAD
1975, 9; PAD district V, 1974, 7, 1975, 656.

in the United States, by month and refining district
unless otherwise stated)

	1975 p							
Domestic demand	Production at refineries	Yield (percent)	Production at gas processing plants	Crude used directly as distillate [1]	Imports	Exports	Total stocks, end of period	Domestic demand
118,898	88,418	22.6	20	53	10,041	2	199,752	122,534
107,765	75,005	22.1	16	48	8,453	50	176,734	106,490
98,088	78,480	21.4	19	49	7,943	1	161,149	102,075
85,566	74,595	21.2	20	59	3,297	51	146,257	92,812
75,949	75,366	20.6	20	61	4,225	7	152,070	73,852
71,311	77,216	20.5	18	43	2,039	48	163,348	67,990
71,566	80,282	19.8	19	47	3,295	11	181,514	65,466
71,575	80,346	19.9	17	47	2,854	49	197,364	67,365
71,561	84,358	21.5	16	49	3,872	1	220,776	64,882
89,496	85,083	22.1	17	43	3,179	1	226,160	82,937
94,699	83,004	21.9	15	43	2,894	10	235,798	76,308
119,442	86,283	21.6	17	45	3,856	36	[2] 208,833	117,130
1,075,916	968,436	21.3	214	587	55,948	267	[2] 208,833	1,039,841
493,352	105,603	22.2	--	--	53,759	3	85,551	463,700
	15,361	26.6						
317,740	5,242	24.5	--	280	196	5	64,922	318,530
	168,313	21.2						
	22,906	26.3						
	88,376	25.9						
130,403	31,690	19.8	214	191	1,441	61	42,388	121,549
	239,224	23.2						
	142,120	22.4						
	12,145	21.4						
	6,749	25.7						
38,746	46,382	29.3	--	69	1	--	3,544	39,954
95,675	84,325	11.9	--	47	551	198	12,428	96,108
1,075,916	968,436	21.3	214	587	55,948	267	[2] 208,833	1,039,841

distillate.
district II, 1974, 33, 1975, 83; PAD district III, 1974, 438, 1975, 376; PAD district IV, 1974, 16,

Table 33.—Salient statistics of residual fuel oil in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1974							1975 p						
	Production	Yield (percent)	Crude used directly as residual [1]	Imports	Exports	Stocks, end of period	Domestic demand	Production	Yield (percent)	Crude used directly as residual [1]	Imports	Exports	Stocks, end of period	Domestic demand
By month:														
January	33,222	9.2	513	53,727	292	46,548	94,102	43,857	11.2	371	51,043	463	69,233	100,514
February	28,808	9.1	407	53,313	317	45,004	83,755	37,912	11.1	371	39,269	528	66,495	79,762
March	28,259	8.2	356	53,118	286	47,222	79,229	40,260	11.0	341	40,051	295	64,148	82,704
April	29,539	8.2	373	47,785	469	51,339	73,111	37,335	10.6	391	31,400	178	66,340	66,756
May	30,835	8.1	364	42,232	357	54,356	70,057	35,678	9.8	451	34,801	246	73,498	63,526
June	30,773	8.0	355	44,989	435	57,891	72,147	34,569	9.2	451	27,128	619	69,660	65,367
July	32,727	8.1	358	45,691	215	59,787	76,665	35,798	8.8	559	35,470	540	71,526	69,421
August	33,072	8.3	351	47,117	932	60,988	78,407	35,522	8.8	399	30,428	371	71,857	65,647
September	30,963	8.4	357	42,644	451	60,251	74,250	35,500	9.1	682	39,356	577	76,938	69,880
October	34,060	8.9	398	45,426	508	58,679	80,948	36,130	9.4	482	37,837	164	81,858	69,365
November	36,861	9.9	545	52,580	241	60,363	88,061	36,426	9.6	623	35,066	376	83,131	70,466
December	41,372	10.5	374	50,535	466	59,694	92,484	41,970	10.5	495	34,070	985	74,126	84,555
Total	[2] 390,491	8.7	4,751	[3] 579,157	4,969	59,694	963,216	[2] 450,957	9.9	5,616	[3] 435,919	5,342	74,126	887,963
By refining district:														
East coast	49,059	10.1	--	[4] 538,573	102	26,961	630,887	61,962	13.0	--	[5] 407,207	12	37,944	532,572
Appalachian No. 1	7,105	11.8				678		6,272	10.8					
Appalachian No. 2	2,093	9.7				405		1,700	8.0					
Indiana, Illinois, Kentucky, etc	48,612	6.2	578	[4] 7,919	64	5,293	85,228	50,723	6.4	579	[5] 13,771	114	9,897	95,176
Minnesota, Wisconsin, etc	6,595	8.1				1,120		6,852	7.9					
Oklahoma, Kansas	8,475	2.5				1,214		10,415	3.0					
Texas inland	8,573	5.6				373		11,597	7.2					
Texas gulf coast	78,607	7.8				5,339		90,259	8.7					
Louisiana gulf coast	33,386	5.4	1,784	11,806	666	3,751	92,372	46,508	7.3	1,783	3,957	458	9,242	103,075
Arkansas, Louisiana inland, etc	8,599	15.0				501		10,744	18.9					
New Mexico	2,837	13.4				108		4,851	18.5					
Rocky Mountain	12,396	8.0	252	--	--	935	12,450	13,030	8.2	252	--	--	1,006	13,198
West coast	124,154	18.0	2,137	[4] 20,859	4,137	13,016	142,279	136,044	19.2	3,002	[5] 10,984	4,758	16,037	143,942
Total	[2] 390,491	8.7	4,751	[3] 579,157	4,969	59,694	963,216	[2] 450,957	9.9	5,616	[3] 435,919	5,342	74,126	887,963

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[1] Represents crude oil used as fuel on leases and for general industrial purposes.
[2] Sulfur content in thousands of barrels: 0–0.50%, 1974, 97,671; 1975, 108,943; 0.51%–1.00%, 1974, 103,358; 1975, 111,516; 1.01%–2.00%, 1974, 105,028; 1975, 123,469; over 2.00%, 1974, 84,434; 1975, 107,029.
[3] Sulfur content in thousands of barrels: 0–0.50%, 1974, 15,304; 1975, 169,533; 0.51%–1.00%, 1974, 453; 1975, 65,700; 1.01%–2.00%, 1974, 1,018; 1975, 66,546; over 2.00%, 1974, 59; 1975, 112,324.
[4] Includes foreign crude oil to be burned as fuel, in thousands of barrels: District I, 4,787; district II, 2,721.
[5] Includes foreign crude oil to be burned as fuel, in thousands of barrels: District I, 6,588; district II, 6,312; district V, 659.

Table 34.—Salient statistics of special naphthas in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1974							1975 p						
	Production at refineries	Yield (percent)	Production at gas-processing plants	Imports	Exports	Total stocks, end of period	Domestic demand	Production at refineries	Yield (percent)	Production at gas-processing plants	Imports	Exports	Total stocks, end of period	Domestic demand
By month:														
January	2,809	0.8	15	5	127	4,556	2,667	2,084	0.5	12	--	140	5,535	2,141
February	2,529	.8	14	162	131	4,462	2,668	1,990	1.0	12	30	151	5,317	2,099
March	2,795	.8	16	151	99	4,595	2,730	2,117	.6	12	1	55	5,606	1,786
April	2,891	.8	16	256	117	4,627	3,014	1,897	.5	12	1	47	5,173	2,296
May	2,968	.8	16	277	135	4,872	2,881	2,339	.6	12	1	118	5,046	2,361
June	2,604	.7	15	--	139	4,901	2,451	2,140	.6	11	--	94	5,000	2,103
July	2,928	.7	16	1	85	4,944	2,817	2,368	.6	10	2	103	4,469	2,808
August	2,937	.7	15	1	118	4,959	2,820	2,128	.5	9	1	90	4,360	2,157
September	2,701	.7	14	1	72	5,001	2,602	2,558	.7	8	2	112	4,481	2,335
October	2,911	.8	13	82	131	5,033	2,843	2,333	.6	9	2	104	4,302	2,419
November	2,818	.8	13	1	81	5,393	2,391	2,552	.7	9	1	72	4,366	2,426
December	2,471	.6	12	1	65	5,720	2,092	2,694	.7	9	2	135	4,377	2,559
Total	33,362	.8	175	938	1,300	5,720	31,976	27,200	.6	125	43	1,221	4,377	27,490
By refining district:														
East coast	27	--	--	2	224	1,117	7,435	163	--	--	--	174	965	7,303
Appalachian No. 1	205	.3	--			50		142	.3	--			69	
Appalachian No. 2	245	1.1	--			25		150	.7	--			26	
Indiana, Illinois, Kentucky, etc	4,501	.6	--	905	162	801	10,975	3,689	.5	--	43	141	799	8,628
Minnesota, Wisconsin, etc	--	--	--			73		--	--	--			61	
Oklahoma, Kansas, etc	2,473	.7	--			265		2,170	.6	--			205	
Texas inland	1,275	.8	--			145		994	.6	--			103	
Texas gulf coast	16,971	1.7	--			2,267		14,210	1.4	--			1,379	
Louisiana gulf coast	152	--	--			65		134	--	--			40	
Arkansas, Louisiana inland, etc	1,898	3.3	175	--	826	242	8,004	1,730	3.0	125	--	840	248	7,606
New Mexico	1	--	--			--		--	--	--			--	
Rocky mountain	108	.1	--	--	5	22	149	65	--	--	--	3	16	68
West coast	5,506	.8	--	31	83	648	5,413	3,753	.5	--	--	63	466	3,885
Total	33,362	.8	175	938	1,300	5,720	31,976	27,200	.6	125	43	1,221	4,377	27,490

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Table 35.—Salient statistics of petrochemical feedstocks in the United States, by month and refining district

(Thousand barrels)

1974	Production: Still gas	Production: Naphtha 400°	Production: Other	Production: Total	Imports (naphtha 400°)	Exports (other)	Stock, end of period: Naphtha 400°	Stock, end of period: Other	Stock, end of period: Total	Domestic demand (all types)
By month:										
January	1,263	4,728	4,176	10,167	701	287	983	1,223	2,206	10,762
February	877	4,921	4,675	10,473	481	512	1,085	1,577	2,662	9,986
March	799	5,189	4,242	10,230	323	535	1,473	1,260	2,733	9,947
April	795	4,409	4,192	9,396	362	843	1,528	1,138	2,666	8,982
May	889	4,954	4,176	10,019	196	286	1,583	1,329	2,912	9,683
June	1,232	5,258	4,660	11,150	83	548	1,727	1,450	3,177	10,420
July	1,184	6,263	5,567	13,014	255	769	1,915	1,280	3,195	12,482
August	1,308	5,948	5,447	12,703	167	446	1,618	1,486	3,104	12,515
September	1,298	5,250	5,087	11,635	443	496	1,528	1,452	2,980	11,706
October	1,464	5,269	5,301	12,034	421	359	1,600	1,482	3,082	11,994
November	1,246	5,330	5,363	11,939	571	181	1,724	1,574	3,298	12,113
December	2,020	5,049	4,935	12,004	361	299	1,898	1,588	3,486	11,878
Total	14,375	62,568	57,821	134,764	4,364	5,561	1,898	1,588	3,486	132,468
By refining district:										
East coast	792	5,456	482	6,730	941	772	--	189	189	11,276
Appalachian No. 1	62	--	742	804			--	7	7	
Appalachian No. 2	--	--	--	--			--	--	--	
Indiana, Illinois, Kentucky, etc	2,664	3,777	1,954	8,395	--	291	192	115	307	10,808
Minnesota, Wisconsin, etc	--	--	--	--			--	--	--	
Oklahoma, Kansas, etc	89	1,052	188	1,329			128	45	173	
Texas inland	300	3,308	3,468	7,076			33	231	264	
Texas gulf coast	9,516	40,030	22,680	72,226			920	298	1,218	
Louisiana gulf coast	777	2,116	26,577	29,470	3,423	2,668	206	529	735	104,265
Arkansas, Louisiana inland, etc	--	329	295	624			6	10	16	
New Mexico	--	--	--	--			--	--	--	
Rocky Mountain	121	--	--	121	--	28	--	--	--	114
West coast	54	6,500	1,435	7,989	--	1,802	413	164	577	6,005
Total	14,375	62,568	57,821	134,764	4,364	5,561	1,898	1,588	3,486	132,468

1975 p										
By month:										
January	1,313	4,790	4,661	10,764	974	377	2,027	1,861	3,888	10,959
February	1,145	3,418	3,011	7,574	--	406	1,857	1,602	3,459	7,597
March	1,077	4,259	4,139	9,475	93	696	1,780	1,528	3,308	9,023
April	1,155	3,932	3,177	8,264	--	839	1,806	1,669	3,475	7,258
May	1,070	3,760	3,344	8,174	100	549	1,550	1,497	3,047	8,153
June	1,298	4,346	3,912	9,556	336	627	1,379	1,468	2,847	9,465
July	1,379	4,632	4,611	10,622	--	638	1,443	1,208	2,651	10,180
August	1,430	4,733	5,144	11,307	380	1,139	1,529	1,176	2,705	10,494
September	1,309	5,418	4,811	11,538	--	893	1,773	1,252	3,025	10,325
October	1,482	5,076	4,811	11,369	--	528	1,541	1,198	2,739	11,127
November	1,704	5,372	4,730	11,806	--	478	1,587	1,400	2,987	11,080
December	1,361	5,034	5,343	11,738	178	867	1,540	1,384	2,924	11,112
Total	15,723	54,770	51,694	122,187	2,061	8,037	1,540	1,384	2,924	116,773
By refining district:										
East coast	586	5,602	207	6,395			--	167	167	
Appalachian No. 1	174	--	229	403	378	410	--	23	23	10,683
Appalachian No. 2	--	--	--	--			--	--	--	
Indiana, Illinois, Kentucky, etc	1,302	2,865	1,694	5,861			68	101	169	
Minnesota, Wisconsin, etc	59	--	--	59	--	319	--	--	--	7,818
Oklahoma, Kansas, etc	--	663	141	804			76	14	90	
Texas inland	293	5,434	3,228	8,955			185	234	419	
Texas gulf coast	10,987	34,630	23,249	68,866			812	326	1,138	
Louisiana gulf coast	759	1,582	21,635	23,976	1,683	5,564	50	291	341	
Arkansas, Louisiana inland, etc	--	271	233	504			3	5	8	93,611
New Mexico	54	--	--	54			--	--	--	
Rocky Mountain	935	--	--	935	--	17	--	--	--	918
West coast	574	3,723	1,078	5,375	--	1,727	346	223	569	3,743
Total	15,723	54,770	51,694	122,187	2,061	8,037	1,540	1,384	2,924	116,773

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[1] Produced at petroleum refineries (excluding ethane and liquefied gases).

Table 36.—Salient statistics of lubricants in the United States, by month and refining district

(Thousand barrels unless otherwise noted)

	Production				Yield (percent)	Imports (all types)	Exports (all types)	Stocks, end of period				Domestic demand (all types)
	Bright stock	Neutral	Other grades	Total				Bright stock	Neutral	Other grades	Total	
1974												
By month:												
January	621	2,661	2,591	5,873	1.6	210	1,023	1,162	4,253	6,601	12,016	5,230
February	517	2,319	2,356	5,192	1.6	171	676	1,167	4,278	6,898	12,343	4,360
March	605	2,757	2,745	6,107	1.8	215	1,021	1,220	4,311	7,198	12,729	4,915
April	610	2,586	2,817	6,013	1.7	118	1,206	1,303	4,301	7,353	12,957	4,697
May	694	2,570	2,810	6,074	1.6	108	1,184	1,300	4,084	7,360	12,744	5,211
June	537	2,695	2,854	6,086	1.6	239	1,020	1,366	4,515	8,075	13,956	4,093
July	474	2,621	2,882	5,977	1.5	139	1,279	1,202	4,492	8,102	13,796	4,997
August	648	2,676	2,690	6,014	1.5	137	1,010	1,279	4,868	8,275	14,422	4,515
September	624	2,670	2,500	5,794	1.6	150	799	1,443	5,102	8,153	14,698	4,869
October	684	2,592	2,665	5,941	1.6	153	918	1,438	5,182	8,241	14,861	5,013
November	576	2,676	2,554	5,806	1.6	90	988	1,435	5,346	8,633	15,414	4,355
December	614	2,540	2,663	5,817	1.5	56	812	1,603	5,509	8,948	16,060	4,415
Total	7,204	31,363	32,127	70,694	1.6	1,786	11,936	1,603	5,509	8,948	16,060	56,670
By refining district:												
East coast	719	2,502	4,265	7,486	1.5	1,547	3,210	170	666	2,754	3,590	22,730
Appalachian No. 1	1,388	2,833	391	4,612	7.6			431	322	589	1,342	
Appalachian No. 2	--	--	--	--	--	32	250	--	--	75	75	13,704
Indiana, Illinois, Kentucky, etc	341	3,051	1,772	5,164	.7			114	778	1,241	2,133	
Minnesota, Wisconsin, etc	--	--	--	--	--			--	--	31	31	
Oklahoma, Kansas, etc	733	3,031	1,731	5,495	1.7			116	485	199	800	
Texas inland	--	--	8	8	--	173	7,425	--	--	16	16	14,810
Texas gulf coast	2,122	9,755	19,671	31,548	3.1			295	1,551	2,682	4,528	
Louisiana gulf coast	560	6,391	1,326	8,277	1.4			108	1,109	396	1,613	
Arkansas, Louisiana inland, etc	--	874	1,288	2,162	3.8			--	75	209	284	
New Mexico	--	--	--	--	--			--	--	3	3	
Rocky Mountain	45	291	86	422	.3	4	7	13	60	16	89	713
West coast	1,296	2,635	1,589	5.520	.8	30	1,044	356	463	737	1,556	4,713
Total	7,204	31,363	32,127	70,694	1.6	1,786	11,936	1,603	5,509	8,948	16,060	56,670

1975 p												
By month:												
January	637	2,274	1,950	4,861	1.3	90	820	1,690	5,754	8,215	15,659	4,533
February	443	1,468	1,743	3,654	1.0	184	767	1,737	5,544	8,262	15,543	3,187
March	497	2,205	1,941	4,643	1.3	137	587	1,697	5,910	8,879	16,486	3,250
April	468	1,983	1,953	4,404	1.3	150	686	1,630	5,626	8,789	16,045	4,309
May	550	1,995	1,980	4,525	1.2	1	955	1,524	5,335	8,547	15,406	4,210
June	539	2,211	1,882	4,632	1.2	71	740	1,502	5,144	8,250	14,896	4,473
July	542	2,296	1,957	4,795	1.2	137	860	1,396	5,291	8,038	14,725	4,243
August	572	2,152	1,948	4,672	1.1	81	710	1,305	4,738	8,116	14,159	4,609
September	524	2,508	1,818	4,850	1.2	67	652	1,309	4,759	7,913	13,981	4,443
October	627	2,518	1,933	5,078	1.3	202	1,060	1,285	4,615	7,443	13,343	4,858
November	648	2,417	1,926	4,991	1.3	106	558	1,457	4,991	7,730	14,178	3,704
December	500	2,487	2,129	5,116	1.2	109	716	1,522	5,168	7,647	14,337	4,350
Total	6,547	26,514	23,160	56,221	1.2	1,335	9,111	1,522	5,168	7,647	14,337	50,169
By refining district:												
East coast	582	2,092	2,701	5,375	1.1			183	555	2,059	2,797	
Appalachian No. 1	1,414	2,654	283	4,351	7.5	1,265	2,824	441	386	363	1,190	19,807
Appalachian No. 2	--	--	--	--	--			--	--	77	77	
Indiana, Illinois, Kentucky, etc	171	2,193	1,293	3,657	.5			80	631	1,004	1,715	
Minnesota, Wisconsin, etc	--	--	--	--	--	9	233	--	--	26	26	11,593
Oklahoma, Kansas, etc	508	2,583	1,639	4,730	1.4			126	469	211	806	
Texas inland	--	--	--	--	--			--	--	13	13	
Texas gulf coast	2,040	8,529	13,953	24,522	2.4			324	1,622	2,524	4,470	
Louisiana gulf coast	498	5,131	766	6,395	1.0	59	5,272	91	861	363	1,315	13,043
Arkansas, Louisiana inland, etc	--	719	1,169	1,888	3.3			--	90	272	362	
New Mexico	--	--	--	--	--			--	--	3	3	
Rocky Mountain	35	281	19	335	.2	--	5	13	66	12	91	546
West coast	1,299	2,332	1,337	4,968	.7	2	777	264	488	720	1,472	5,180
Total	6,547	26,514	23,160	56,221	1.2	1,335	9,111	1,522	5,168	7,647	14,337	50,169

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Table 37.—Salient statistics of wax in the United States, by type, month, and refining district

(Thousand barrels) [1]

	Production				Imports (all types)	Exports (all types)	Stocks, end of period				Domestic demand (all types)
	Micro-crystal-line	Crystal-line, fully refined	Crystal-line, other	Total			Micro-crystal-line	Crystal-line, fully refined	Crystal-line, other	Total	
1974											
By month:											
January	90	298	181	569	99	54	107	374	428	909	695
February	90	235	190	515	73	62	107	360	455	922	513
March	103	296	195	594	90	114	115	386	367	868	624
April	103	248	241	592	75	75	117	379	408	904	556
May	105	263	235	603	101	63	120	387	438	945	600
June	93	262	284	639	85	72	130	415	461	1,006	591
July	95	237	275	607	86	78	133	406	458	997	624
August	98	293	289	680	114	91	134	447	496	1,077	623
September	84	235	221	540	46	36	130	447	537	1,114	513
October	104	231	247	582	59	55	144	446	549	1,139	561
November	82	217	216	515	62	61	159	457	531	1,147	508
December	89	217	187	493	66	118	179	501	515	1,195	393
Total	1,136	3,032	2,761	6,929	956	879	179	501	515	1,195	6,801
By refining district:											
East coast	78	362	18	458	847	137	8	55	17	80	2,105
Appalachian No. 1	142	70	390	602			52	8	82	142	
Appalachian No. 2	--	--	--	--			--	--	--	--	
Indiana, Illinois, Kentucky, etc	--	232	184	416	3	33	--	11	133	144	1,346
Minnesota, Wisconsin, etc	--	--	--	--			--	--	--	--	
Oklahoma, Kansas, etc	296	261	437	994			50	62	14	126	
Texas inland	87	--	--	87			20	--	--	20	
Texas gulf coast	162	526	931	1,619			40	59	174	273	
Louisiana gulf coast	27	886	95	1,008	88	629	3	212	33	248	2,048
Arkansas, Louisiana inland, etc	329	--	--	329			3	--	--	3	
New Mexico	--	--	--	--			--	--	--	--	
Rocky Mountain	14	68	29	111	--	--	3	41	19	63	100
West coast	1	627	677	1,305	18	80	--	53	43	96	1,202
Total	1,136	3,032	2,761	6,929	956	879	179	501	515	1,195	6,801

1975 p											
By month:											
January	89	152	217	458	55	30	196	468	424	1,088	590
February	43	102	135	280	78	28	191	436	387	1,014	404
March	58	124	133	315	58	70	185	413	371	969	348
April	73	158	193	424	114	33	174	383	419	976	498
May	75	188	173	436	4	77	177	367	403	947	392
June	61	181	198	440	33	40	170	373	416	959	421
July	83	234	213	530	57	71	163	389	399	951	524
August	96	233	200	529	8	47	172	350	390	912	529
September	89	198	200	487	62	58	160	293	354	807	596
October	98	252	258	608	87	64	146	265	332	743	695
November	84	270	265	619	64	41	124	299	394	817	568
December	83	246	210	539	64	48	146	312	403	861	511
Total	932	2,338	2,395	5,665	684	607	146	312	403	861	6,076
By refining district:											
East coast	39	304	--	343			7	48	18	73	
Appalachian No. 1	137	26	397	560	668	87	38	6	83	127	1,718
Appalachian No. 2	--	--	--	--			--	--	--	--	
Indiana, Illinois, Kentucky, etc	--	209	99	308			--	7	10	17	
Minnesota, Wisconsin, etc	--	--	--	--	2	23	--	--	--	--	1,421
Oklahoma, Kansas, etc	193	200	592	985			44	45	15	104	
Texas inland	48	--	--	48			11	--	--	11	
Texas gulf coast	127	557	951	1,635			30	20	226	276	
Louisiana gulf coast	33	638	52	723	14	445	15	144	24	183	2,191
Arkansas, Louisiana inland, etc	355	--	--	355			1	--	--	1	
New Mexico	--	--	--	--			--	--	--	--	
Rocky Mountain	--	41	--	41	--	--	--	6	--	6	113
West coast	--	363	304	667	--	52	--	36	27	63	633
Total	932	2,338	2,395	5,665	684	607	146	312	403	861	6,076

p Preliminary.
[1] Conversion factor: 280 pounds=1 barrel.

Table 38.—Salient statistics of petroleum coke in the United States, by month and refining district

(Thousand barrels unless otherwise stated) [1]

	1974							1975 p						
	Production			Yield (percent)	Exports	Stocks, end of period	Domestic demand	Production			[illegible]eld ([illegible])	Exports	Stocks, end of period	Domestic demand
	Marketable	Catalyst	Total					Marketable	Catalyst	Total				
By month:														
January	5,350	4,913	10,263	2.8	2,806	9,642	7,789	5,459	5,433	10,892	2.8	3,283	5,384	7,645
February	4,730	4,491	9,221	2.9	2,837	9,057	6,969	5,114	4,711	9,825	2.9	2,803	5,448	6,958
March	4,953	5,017	9,970	2.9	2,597	8,266	8,164	5,492	5,031	10,523	2.9	3,359	5,712	6,900
April	5,114	4,933	10,047	2.8	3,524	7,756	7,033	5,494	4,721	10,215	2.9	2,762	5,955	7,210
May	5,699	5,030	10,729	2.8	4,436	7,455	6,594	5,085	5,070	10,155	2.8	3,334	6,053	6,723
June	5,624	4,829	10,453	2.7	3,891	6,898	7,119	5,419	5,279	10,698	2.9	3,710	6,078	6,963
July	5,573	5,288	10,861	2.7	4,147	6,572	7,040	5,721	5,574	11,295	2.8	2,549	6,415	8,409
August	5,421	5,426	10,847	2.7	3,873	6,354	7,192	5,323	5,667	10,990	2.7	2,968	6,627	7,810
September	5,195	4,995	10,190	2.8	2,252	6,532	7,760	5,613	5,489	11,102	2.8	3,020	7,177	7,532
October	5,462	4,870	10,332	2.7	3,787	6,472	6,605	6,016	5,521	11,537	3.0	2,809	7,386	8,519
November	5,170	4,705	9,875	2.7	3,012	6,217	7,118	5,571	5,006	10,577	2.8	2,607	7,825	7,531
December	5,659	5,299	10,958	2.8	4,082	5,420	7,673	6,193	5,239	11,432	2.9	4,049	7,360	7,848
Total	63,950	59,796	123,746	2.8	41,244	5,420	87,056	66,500	62,741	129,241	2.8	37,253	7,360	90,048
By refining district:														
East coast	4,932	6,675	11,607	2.4	1,056	1,894	11,916	5,200	8,106	13,306	2.8	1,252	3,176	11,029
Appalachian No. 1	--	395	395	.7		--		--	257	257	.4		--	
Appalachian No. 2	--	349	349	1.6		--		--	253	253	1.2		--	
Indiana, Illinois, Kentucky, etc	10,257	12,490	22,747	2.9	2,572	272	35,458	10,854	13,142	23,996	3.0	3,296	364	35,013
Minnesota, Wisconsin, etc	1,190	1,382	2,572	3.2		--		1,594	1,465	3,059	3.5		316	
Oklahoma, Kansas, etc	6,008	4,653	10,661	3.2		222		6,048	5,558	11,606	3.4		419	
Texas inland	454	3,000	3,454	2.2		5		438	2,949	3,387	2.1		2	
Texas gulf coast	8,199	14,204	22,403	2.2		43		9,059	14,306	23,365	2.3	13,668	256	27,134
Louisiana gulf coast	8,322	4,714	13,036	2.1	14,936	143	25,219	8,717	4,728	13,445	2.1		116	
Arkansas, Louisiana inland, etc	445	298	743	1.3		53		397	306	703	1.2		168	
New Mexico	--	202	202	.9		--		--	200	200	.8		--	
Rocky Mountain	1,192	2,662	3,854	2.5	7	1,651	4,021	1,215	2,424	3,639	2.3	2	1,517	3,771
West coast	22,951	8,772	31,723	4.6	22,673	1,137	10,442	22,978	9,047	32,025	4.5	19,035	1.026	13,101
Total	63,950	59,796	123,746	2.8	41,244	5,420	87,056	66,500	62,741	129,241	2.8	37,253	7,360	90,048

p Preliminary.
[1] Conversion factor: 5.0 barrels = 1 short ton.

Table 39.—Salient statistics of petroleum asphalt in the United States, by month and refining district

(Thousand short tons) [1]

	1974					1975 p				
	Production	Imports (including natural)	Exports	Stocks, end of period	Domestic demand	Production	Imports (including natural)	Exports	Stocks, end of period	Domestic demand
By month:										
January	1,600	187	4	3,266	1,250	1,488	46	5	4,436	1,017
February	1,576	212	2	3,663	1,389	1,367	55	3	4,897	958
March	2,092	156	10	4,210	1,691	1,676	40	6	5,498	1,109
April	2,374	250	13	4,626	2,195	1,711	42	5	5,584	1,662
May	2,672	477	13	4,687	3,075	2,385	95	4	5,746	2,314
June	2,934	140	6	4,462	3,293	2,627	122	6	5,375	3,114
July	3,204	118	9	4,128	3,647	3,021	98	5	5,165	3,323
August	3,143	119	5	3,680	3,705	2,946	143	5	4,777	3,472
September	2,841	117	2	3,141	3,493	2,696	86	4	4,114	3,441
October	3,052	134	2	2,801	3,524	2,630	76	4	3,592	3,224
November	2,412	76	4	3,092	2,193	2,114	55	5	3,669	2,087
December	1,961	60	4	3,885	1,224	1,513	43	6	4,144	1,076
Total	29,861	2,046	74	3,885	30,679	26,174	901	58	4,144	26,797
By refining district:										
East coast	5,886	1,961	11	907	9,293	4,854	894	8	831	6,742
Appalachian No. 1	271			63		343			150	
Appalachian No. 2	248	7	6	133	9,898	255	1	9	141	9,446
Illinois, Indiana, Kentucky, etc	6,126			824		5,430			924	
Minnesota, Wisconsin, North Dakota	1,081			153		931			179	
Oklahoma, Kansas, etc	2,685			314		2,476			317	
Texas inland	1,310	76	29	160	5,583	1,211	6	21	100	5,213
Texas gulf coast	1,759			137		1,352			105	
Louisiana gulf coast	2,651			250		2,015			241	
Arkansas, Louisiana inland, etc	1,632			170		1,477			129	
New Mexico	165			41		169			49	
Rocky Mountain	1,798	--	3	300	1,793	1,774	--	2	433	1,841
West coast	4,249	2	25	433	4,112	3,887	(2)	18	545	3,555
Total	29,861	2,046	74	3,885	30,679	26,174	901	58	4,144	26,797

Note: In the refining-district section, the imports, exports and domestic demand figures are printed once for each bracketed group of districts (East coast–Appalachian No. 1; Appalachian No. 2–Oklahoma, Kansas, etc; Texas inland–New Mexico).

p Preliminary.
[1] Conversion factor: 5.5 barrels=1 short ton.
[2] Less than ½ unit.

Table 40.—Statistical summary of petroleum asphalt and road oil

(Thousand short tons) [1]

	1971	1972	1973	1974	1975 [p]
Petroleum asphalt:					
Production	28,553	28,235	30,524	29,861	26,174
Imports (including natural)	1,312	1,684	1,535	2,046	901
Exports	55	61	62	74	58
Stocks, end of period	3,855	3,934	2,731	3,885	4,144
Apparent domestic consumption	28,823	29,779	33,200	30,679	26,797
Petroleum asphalt shipments:					
Paving	23,821	r 24,305	27,041	24,642	21,483
Roofing	4,362	5,347	5,677	4,815	4,812
All other	1,840	r 1,469	1,615	1,578	1,296
Total	30,023	31,121	34,333	31,035	27,591
Road oil:					
Production	1,592	1,444	1,332	1,302	899
Stocks, end of period	164	237	145	196	104
Apparent domestic consumption	1,543	1,371	1,424	1,251	991
Road oil shipments	1,543	1,371	1,424	1,251	991

p Preliminary. r Revised.
[1] Conversion factor: 5.5 barrels=1 short ton.

Table 41.—Salient statistics of road oil in the United States, by month and refining district

(Short tons) [1]

	1974			1975 [p]		
	Production	Stocks, end of period	Domestic demand	Production	Stocks, end of period	Domestic demand
By month:						
January	42,546	166,909	20,909	75,273	228,727	42,909
February	60,727	202,727	24,909	41,636	261,273	9,091
March	98,727	273,091	28,364	47,818	291,273	17,818
April	107,455	318,364	62,182	48,000	304,727	34,546
May	128,545	359,818	87,091	74,000	303,455	75,273
June	151,818	339,273	172,364	160,727	338,000	126,182
July	194,545	316,000	217,818	111,818	151,636	298,182
August	184,727	299,091	201,636	100,364	131,273	120,727
September	128,364	254,182	173,273	69,273	124,909	75,636
October	101,636	183,273	172,545	54,000	122,182	56,727
November	50,546	159,818	74,000	72,909	108,545	86,546
December	52,546	196,364	16,000	43,091	103,818	47,818
Total	1,302,182	196,364	1,251,091	898,909	103,818	991,455
By refining district:						
East coast	--	--	74,546	--	--	1,636
Appalachian No. 1	64,545	1,636		--	--	
Appalachian No. 2	--	--	712,727	--	--	523,091
Indiana, Illinois, Kentucky, etc	564,727	51,091		442,182	65,818	
Minnesota, Wisconsin, North Dakota	16,546	--		15,091	--	
Oklahoma, Kansas, etc	158,546	9,091		92,545	21,091	
Texas inland	4,364	--	8,182	4,000	--	84,182
Texas gulf coast	--	--		80,545	--	
Louisiana gulf coast	--	--		--	--	
Arkansas, Louisiana inland, etc	3,818	--		--	364	
New Mexico	--			--	--	
Rocky Mountain	97,454	3,273	98,000	75,091	10,909	67,455
West coast	392,182	131,273	357,636	189,455	5,636	315,091
Total	1,302,182	196,364	1,251,091	898,909	103,818	991,455

p Preliminary.
[1] Conversion factor: 5.5 barrels=1 short ton.

Table 42.—Production of miscellaneous finished oils at refineries and natural gas processing plants in the United States in 1975, by district and class

(Thousand barrels)

District	Absorption	Petrolatum	Specialty oils [1]	Petrochemicals	Other products [2]	Total
East coast	--	47	678	1,284	168	2,177
Appalachian No. 1	6	91	89	36	3,316	3,538
Appalachian No. 2	--	--	32	15	--	47
Indiana, Illinois, Kentucky, etc	80	24	728	869	3,340	5,041
Minnesota, Wisconsin, North Dakota, South Dakota	--	--	--	106	--	106
Oklahoma, Kansas, etc	151	62	481	--	432	1,126
Texas inland	439	--	1,056	59	244	1,798
Texas gulf coast	52	711	1,420	3,790	2,466	8,439
Louisiana gulf coast	254	--	509	5,778	1,022	7,563
Arkansas, Louisiana inland, etc	55	--	--	418	--	473
Rocky Mountain and New Mexico	2	--	--	35	--	37
West coast	15	12	925	799	119	1,870
Total:						
1975	1,054	947	5,918	13,189	11,107	32,215
1974	818	842	6,327	13,507	3,752	25,246

[1] Specialty oils include hydraulic, 183; insulating, 255; medicinal, 148; rust preventatives, 2; sand-frac, 1,056; spray oils, 322; and other, 3,952.
[2] Includes SNG feedstock.

Table 43.—Receipts of domestic and foreign crude petroleum at refineries in the United States

(Million barrels)

Method of transportation	1971	1972	1973	1974	1975 p
By water:					
Intrastate	160.9	155.4	148.9	130.4	134.9
Interstate	430.0	298.5	249.8	211.5	170.2
Foreign	352.6	490.5	775.3	896.1	1,100.9
Total by water	943.5	944.4	1,174.0	1,238.0	1,406.0
By pipeline:					
Intrastate	1,702.2	1,832.0	1,796.9	1,692.5	1,641.0
Interstate	1,132.3	1,131.8	1,108.1	1,061.4	1,021.5
Foreign	260.4	317.8	408.7	370.7	397.5
Total by pipeline	3,094.9	3,281.6	3,313.7	3,124.6	3,060.0
By tank cars and trucks:					
Intrastate	37.0	47.5	45.7	51.7	56.5
Interstate	5.4	5.7	12.4	22.0	23.7
Foreign	--	--	--	--	--
Total by tank cars and trucks	42.4	53.2	58.1	73.7	80.2
Grand total	4,080.8	4,279.2	4,545.8	4,436.3	4,546.2

p Preliminary.

Table 44.—Interdistrict movements by tanker and barge of crude oil and petroleum products in 1975, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1975	Total 1974
Gulf coast to east coast, total:[1]														
Crude oil	2,368	1,608	2,345	2,807	3,680	1,886	1,223	1,113	1,283	2,044	1,810	1,627	23,794	52,337
Unfinished oils	1,371	977	1,306	533	1,191	873	918	1,816	20	317	931	685	10,938	18,128
Gasoline:														
Motor	17,130	12,720	14,738	16,506	16,332	14,938	17,048	17,245	14,629	13,700	15,178	15,841	186,005	176,908
Aviation	195	135	241	164	179	202	466	191	284	160	328	201	2,746	2,980
Total gasoline	17,325	12,855	14,979	16,670	16,511	15,140	17,514	17,436	14,913	13,860	15,506	16,042	188,751	179,888
Special naphthas	399	375	587	330	433	592	770	463	742	528	1,051	769	7,039	7,646
Kerosine	1,034	1,086	718	262	402	451	711	613	1,179	831	797	887	8,971	10,879
Distillate fuel oil	14,045	11,858	11,862	10,774	11,176	8,278	9,846	6,422	10,316	9,489	9,354	10,740	124,160	93,460
Residual fuel oil	3,194	4,203	4,217	4,317	4,348	3,785	3,907	6,143	4,615	3,733	6,499	5,759	54,720	36,023
Jet fuel:														
Naphtha-type	548	411	1,073	769	817	622	585	915	872	1,090	982	715	9,399	9,481
Kerosine-type	2,849	2,918	3,248	2,416	3,237	3,659	3,397	3,302	2,548	3,125	2,813	2,784	36,296	27,994
Total jet fuel	3,397	3,329	4,321	3,185	4,054	4,281	3,982	4,217	3,420	4,215	3,795	3,499	45,695	37,475
Lubricating oil	841	700	776	767	857	854	859	1,234	898	1,066	883	739	10,474	12,922
Wax	18	17	18	11	19	11	16	20	20	19	19	24	212	353
Asphalt and road oil	119	120	467	535	378	258	334	299	183	267	277	232	3,469	5,796
Liquefied gases	143	62	--	60	76	61	48	23	67	143	213	157	1,053	1,541
Petrochemical feedstocks	217	317	333	231	327	436	405	560	317	247	228	293	3,911	3,757
Other products	188	129	156	136	225	377	215	253	185	320	289	363	2,836	2,536
Total	44,659	37,636	42,085	40,618	43,677	37,283	40,748	40,612	38,158	37,079	41,652	41,816	486,023	462,741
Gulf coast to PAD district II:														
Crude oil	1,435	839	1,583	1,060	995	1,023	1,146	1,170	1,065	1,095	741	1,039	13,191	12,841
Unfinished oils	--	--	--	--	--	17	--	--	--	--	--	--	17	59
Gasoline:														
Motor	2,187	1,668	1,848	1,675	2,253	2,491	3,310	2,372	2,276	2,347	2,836	2,251	27,514	27,357
Aviation	27	29	22	15	54	44	72	97	78	51	25	31	545	533
Total gasoline	2,214	1,697	1,870	1,690	2,307	2,535	3,382	2,469	2,354	2,398	2,861	2,282	28,059	27,890
Special naphthas	206	191	153	120	155	249	321	197	244	306	263	239	2,644	3,275
Kerosine	66	144	150	14	54	4	2	--	60	59	92	149	794	764
Distillate fuel oil	532	317	363	360	603	896	651	728	865	562	920	1,007	7,804	6,449
Residual fuel oil	1,323	959	822	1,114	882	1,090	770	637	1,625	917	841	741	11,721	13,209

Jet fuel:														
Naphtha-type	--	--	--	46	--	--	--	56	--	--	60	--	162	227
Kerosine-type	176	186	206	129	207	209	156	251	146	195	338	240	2,439	2,471
Total jet fuel	176	186	206	175	207	209	156	307	146	195	398	240	2,601	2,698
Lubricating oil	212	234	110	152	186	431	142	266	262	258	598	164	3,015	4,125
Wax	--	--	--	--	--	--	--	--	--	--	--	--	--	8
Asphalt and road oil	77	28	106	149	195	366	422	400	376	225	205	199	2,748	3,684
Liquefied gases	2	3	--	--	--	--	--	--	--	--	--	--	5	71
Petrochemical feedstocks	80	52	27	35	89	55	200	91	203	138	103	119	1,192	1,381
Other products	7	7	18	--	10	14	9	10	56	58	86	--	275	1,095
Total	6,330	4,657	5,408	4,869	5,683	6,889	7,201	6,275	7,256	6,211	7,108	6,179	74,066	77,549
Gulf coast to west coast:														
Crude oil	--	--	--	--	--	--	--	--	--	--	--	--	--	564
Unfinished oils	--	--	--	--	--	--	--	--	--	--	--	--	--	288
Motor gasoline	74	--	410	204	1,105	831	315	--	--	--	525	--	3,464	1,392
Special naphthas	--	--	--	1	--	2	--	--	--	4	--	6	13	--
Distillate fuel oil	110	1	--	--	99	--	12	--	--	--	13	--	235	2,279
Residual fuel oil	--	--	250	--	248	519	241	244	492	261	245	--	2,500	316
Jet fuel:														
Naphtha-type	--	--	--	159	--	--	--	--	--	--	--	--	159	489
Kerosine-type	--	--	--	--	68	--	--	--	--	--	224	--	292	1,532
Total jet fuel	--	--	--	159	68	--	--	--	--	--	224	--	451	2,021
Lubricating oil	--	72	178	52	150	49	249	84	178	74	183	72	1,341	1,671
Petrochemical feedstocks	--	--	--	--	--	--	--	28	20	--	20	19	87	105
Other products	--	--	21	--	6	--	2	--	5	--	7	--	41	15
Total	184	73	859	416	1,676	1,401	819	356	695	339	1,217	97	8,132	8,651
West coast to east coast:														
Lubricating oil	--	18	50	--	19	61	--	35	15	--	22	--	220	785
Other products	--	16	14	--	--	6	--	--	--	--	--	--	36	324
Total	--	34	64	--	19	67	--	35	15	--	22	--	256	1,109
West coast to gulf coast:														
Distillate fuel oil	--	--	--	--	--	--	--	403	--	--	--	--	403	--
Residual fuel oil	121	--	262	181	--	258	--	--	--	--	--	--	822	--
Total	121	--	262	181	--	258	--	403	--	--	--	--	1,225	--

[1] Breakdown by region shown in table 45.

Table 45.—Tanker and barge movements of crude oil and petroleum products from the gulf coast to the east coast in 1975, by region and month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1975	Total 1974
To New England:														
Gasoline:														
Motor	2,119	1,984	1,934	2,408	2,503	3,468	1,478	2,889	1,904	2,330	1,830	2,311	27,158	24,084
Aviation	9	9	16	44	9	41	22	20	62	12	34	17	295	357
Total gasoline	2,128	1,993	1,950	2,452	2,512	3,509	1,500	2,909	1,966	2,342	1,864	2,328	27,453	24,441
Special naphthas	47	9	72	46	29	91	31	--	52	37	31	26	471	527
Kerosine	206	197	117	86	60	90	80	84	120	278	104	244	1,666	1,815
Distillate fuel oil	4,840	4,314	4,509	2,907	3,115	2,119	828	2,680	2,953	3,623	4,153	4,645	40,686	34,610
Residual fuel oil	454	975	847	870	843	701	184	895	1,012	612	423	546	8,362	7,849
Jet fuel:														
Naphtha-type	--	--	175	98	100	--	--	104	--	--	114	--	591	516
Kerosine-type	345	450	497	125	550	240	406	396	586	401	733	371	5,100	5,623
Total jet fuel	345	450	672	223	650	240	406	500	586	401	847	371	5,691	6,139
Lubricating oil	120	--	22	--	50	--	14	12	26	13	6	3	266	612
Asphalt and road oil	--	--	--	--	--	--	--	--	--	--	--	--	--	124
Petrochemical feedstocks	5	--	9	5	--	10	--	--	8	13	--	--	50	58
Other products	28	--	1	--	5	2	3	--	2	1	--	--	42	48
Total	8,173	7,938	8,199	6,589	7,264	6,762	3,046	7,080	6,725	7,320	7,428	8,163	84,687	76,223
To Central Atlantic: [1]														
Crude oil	2,368	1,608	2,345	2,807	3,680	1,886	1,223	1,113	1,185	2,044	1,810	1,627	23,696	51,990
Unfinished oils	710	777	1,306	383	1,191	873	815	1,465	20	216	767	556	9,079	16,729
Gasoline:														
Motor	5,908	3,206	4,899	4,619	4,643	3,992	5,348	5,246	4,439	2,974	3,855	4,923	54,052	54,644
Aviation	47	28	48	47	25	64	280	62	24	35	73	40	773	767
Total gasoline	5,955	3,234	4,947	4,666	4,668	4,056	5,628	5,308	4,463	3,009	3,928	4,963	54,825	52,411
Special naphthas	204	250	400	195	231	315	583	309	506	397	856	552	4,798	4,796
Kerosine	613	739	494	158	334	345	411	268	447	381	445	337	4,972	5,397
Distillate fuel oil	6,969	5,864	5,065	5,547	5,579	3,977	6,138	1,410	4,512	3,875	3,271	3,616	55,823	27,671
Residual fuel oil	2,011	1,822	2,377	1,999	2,221	1,512	2,185	2,251	1,819	1,544	2,693	2,243	24,677	20,739

Jet fuel:														
Naphtha-type	58	--	--	--	135	--	361	--	--	157	174	196	1,081	444
Kerosine-type	453	572	936	786	905	604	1,561	914	1,086	417	560	764	9,558	5,740
Total jet fuel	511	572	936	786	1,040	604	1,922	914	1,086	574	734	960	10,639	6,184
Lubricating oil	604	536	674	542	625	719	690	1,012	740	913	705	647	8,407	10,207
Wax	18	17	18	11	19	11	16	20	20	19	19	24	212	352
Asphalt and road oil	--	--	--	--	16	9	--	44	--	34	34	--	137	291
Liquefied gases	--	--	--	--	--	--	--	--	--	--	--	--	--	492
Petrochemical feedstocks	212	274	324	179	327	389	395	557	289	234	206	250	3,636	3,270
Other products	116	72	115	71	113	137	97	107	69	152	127	207	1,383	1,668
Total	20,291	15,765	19,001	17,344	20,044	14,833	20,103	14,778	15,156	13,392	15,595	15,982	202,284	202,197
To Lower Atlantic:														
Crude oil	--	--	--	--	--	--	--	--	98	--	--	--	98	347
Unfinished oils	661	200	--	150	--	--	103	351	--	101	164	129	1,859	1,399
Gasoline:														
Motor	9,103	7,530	7,905	9,479	9,186	7,478	10,222	9,110	8,286	8,396	9,493	8,607	104,795	101,180
Aviation	139	98	177	73	145	97	164	109	198	113	221	144	1,678	1,856
Total gasoline	9,242	7,628	8,082	9,552	9,331	7,575	10,386	9,219	8,484	8,509	9,714	8,751	106,473	103,036
Special naphthas	148	116	115	89	173	186	156	154	184	94	164	191	1,770	2,323
Kerosine	215	150	107	18	8	16	220	261	612	172	248	306	2,333	3,667
Distillate fuel oil	2,236	1,680	2,288	2,320	2,482	2,182	2,880	2,332	2,851	1,991	1,930	2,479	27,651	31,179
Residual fuel oil	729	1,406	993	1,448	1,284	1,572	1,538	2,997	1,784	1,577	3,383	2,970	21,681	7,435
Jet fuel:														
Naphtha-type	490	411	898	671	582	622	224	811	872	933	694	519	7,727	8,521
Kerosine-type	2,051	1,896	1.815	1,505	1,782	2,815	1,430	1,992	876	2,307	1,520	1,649	21,638	16,631
Total jet fuel	2,541	2,307	2,713	2,176	2,364	3,437	1,654	2,803	1,748	3,240	2,214	2,168	29,365	25,152
Lubricating oil	117	164	80	225	182	135	155	210	132	140	172	89	1,801	2,103
Wax	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Asphalt and road oil	119	120	467	535	362	249	334	255	183	233	243	232	3,332	5,381
Liquefied gases	143	62	--	60	76	61	48	23	67	143	213	157	1,053	1,049
Petrochemical feedstocks	--	43	--	47	--	37	10	3	20	--	22	43	225	429
Other products	44	57	40	65	107	238	115	146	114	167	162	156	1,411	820
Total	16,195	13,933	14,885	16,685	16,369	15,688	17,599	18,754	16,277	16,367	18,629	17,671	199,052	184,321

[1] Includes data formerly shown as barge movements to district I.

Table 46.—Transportation of petroleum products by pipeline between PAD districts in the United States in 1975, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1975	Total 1974
From district I to district II:														
Gasoline:														
Motor	3,801	3,362	4,051	4,200	4,222	3,897	4,351	4,457	4,151	4,112	3,750	4,536	48,890	45,986
Aviation	6	5	3	--	7	4	3	5	7	3	4	3	50	46
Total gasoline	3,807	3,367	4,054	4,200	4,229	3,901	4,354	4,462	4,158	4,115	3,754	4,539	48,940	46,032
Jet fuel:														
Naphtha-type	--	--	--	--	--	--	--	--	--	--	--	--	--	302
Kerosine-type	203	202	147	98	105	63	58	119	140	150	163	142	1,590	1,484
Total jet fuel	203	202	147	98	105	63	58	119	140	150	163	142	1,590	1,786
Kerosine	66	6	6	--	11	--	17	35	--	14	58	10	223	270
Distillate fuel oil	1,185	1,180	1,062	919	880	1,062	1,162	1,121	1,142	1,270	1,241	1,216	13,440	11,605
From district II to district I:														
Gasoline (motor)	941	691	767	870	957	996	1,088	893	1,066	1,004	908	990	11,171	12,440
Jet fuel (naphtha-type)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Kerosine	22	--	8	--	--	7	--	--	--	--	--	15	52	45
Distillate fuel oil	147	77	91	94	54	96	93	79	73	100	46	49	999	1,167
Natural gas liquids	1,586	1,443	1,460	1,557	1,620	1,716	1,580	1,985	1,828	1,535	1,370	1,456	19,136	10,351
From district II to district III:														
Gasoline (motor)	1,538	1,380	1,521	1,384	1,968	1,653	1,712	1,654	1,503	1,620	1,375	1,507	18,815	19,582
Jet fuel:														
Naphtha-type	--	29	80	79	80	--	40	40	--	79	39	89	555	513
Kerosine-type	--	1	--	1	1	1	--	1	1	1	--	1	8	7
Total jet fuel	--	30	80	80	81	1	40	41	1	80	39	90	563	520
Distillate fuel oil	529	412	488	424	375	442	441	392	455	432	341	476	5,207	5,466
Natural gas liquids	373	351	364	337	356	333	406	385	347	395	271	298	4,216	3,886
From district II to district IV:														
Gasoline (motor)	162	199	242	249	305	298	370	376	411	475	642	440	4,169	2,415
Distillate	34	21	23	36	35	9	34	30	33	60	68	77	460	585
From district III to district I:														
Gasoline:														
Motor	25,457	24,822	26,601	28,325	28,819	30,063	31,929	34,783	29,871	29,153	29,215	34,233	353,271	321,065
Aviation	18	16	13	--	14	43	19	14	23	20	47	15	242	206
Total gasoline	25,475	24,838	26,614	28,325	28.833	30,106	31,948	34,797	29,894	29,173	29,262	34,248	353,513	321,271
Jet fuel:														
Naphtha-type	100	129	99	75	105	135	97	133	124	135	103	83	1,318	1,423
Kerosine-type	5.263	4.244	4,210	4,188	3,837	3,305	3,778	4,534	3.797	4.147	3,706	4.121	49,130	49,952
Total jet fuel	5,363	4,373	4,309	4,263	3,942	3,440	3,875	4,667	3,921	4,282	3,809	4,204	50,448	51,375
Kerosine	1,209	765	734	494	490	236	438	389	684	1,040	891	1,349	8,719	8,147
Distillate fuel oil	18,465	14,847	14,997	13,134	12,619	12,450	12,041	14,143	12,607	13,798	13,214	15,159	167,474	173,417
Natural gas liquids	2,019	1,403	1,434	878	658	1,045	1,307	1,929	1,495	1,445	1,410	2,357	17,380	15,846

From district III to district II:														
Gasoline:														
Motor	4,518	4,206	5,358	5,279	4,680	4,328	5,023	3,462	6,169	5,599	5,716	5,237	59,575	65,254
Aviation	136	86	119	57	45	88	77	140	100	142	118	54	1,162	1,267
Total gasoline	4,654	4,292	5,477	5,336	4,725	4,416	5,100	3,602	6,269	5,741	5,834	5,291	60,737	66,521
Jet fuel:														
Naphtha-type	--	1	--	1	--	--	--	--	--	--	1	--	3	69
Kerosine-type	81	177	125	189	139	86	63	57	455	387	66	28	1,853	3,109
Total jet fuel	81	178	125	190	139	86	63	57	455	387	67	28	1,856	3,178
Kerosine	178	56	107	155	180	4	161	70	85	53	3	29	1,081	2,043
Distillate fuel oil	1,403	989	835	1,379	1,138	1,436	1,362	697	1,430	1,821	1,419	1,308	15,277	25,088
Natural gas liquids	8,728	7,831	7,984	7,222	6,236	5,927	6,503	6,022	7,598	7,680	8,327	9,143	89,201	75,576
From district III to district IV:														
Gasoline:														
Motor	492	389	451	357	377	308	314	360	343	289	304	265	4,249	5,146
Aviation	9	10	[illegible]	10	11	15	16	17	13	14	19	13	159	159
Total gasoline	501	399	[illegible]	367	388	323	330	377	356	303	323	278	4,408	5,305
Jet fuel (kerosine-type)	310	256	[illegible]	271	308	331	362	361	329	296	229	250	3,579	3,824
Kerosine	1	1	[illegible]	--	--	--	--	--	--	--	2	--	4	1
Distillate fuel oil	59	44	[illegible]	46	65	45	53	46	39	37	55	34	573	562
Natural gas liquids	159	118	93	66	42	23	48	74	89	97	173	183	1,165	963
From district III to district V:														
Gasoline (motor)	1,117	975	988	1,027	1,066	1,009	916	1,042	939	981	919	948	11,927	12,190
Jet fuel:														
Naphtha-type	123	104	51	23	73	67	32	58	67	61	106	96	861	894
Kerosine-type	122	92	55	29	79	109	89	116	71	108	121	159	1,150	1,252
Total jet fuel	245	196	106	52	152	176	121	174	138	169	227	255	2,011	2,146
Distillate fuel oil	358	346	395	395	353	297	344	323	316	439	417	408	4,391	4,481
From district IV to district II:														
Gasoline (motor)	364	350	327	342	382	456	592	612	434	413	382	369	5,023	5,020
Naphtha-type	60	61	30	17	39	45	29	41	36	40	39	73	510	389
Kerosine-type	3	--	6	--	--	5	2	4	11	7	--	10	48	61
Total jet fuel	63	61	36	17	39	50	31	45	47	47	39	83	558	450
Kerosine	--	8	--	4	5	--	--	--	--	--	--	--	17	19
Distillate fuel oil	345	238	288	257	329	310	316	321	355	318	243	271	3,591	3,720
Natural gas liquids	--	--	--	--	--	--	--	--	--	--	--	--	--	14
From district IV to district III:														
Natural gas liquids	256	192	274	259	300	307	336	332	280	291	291	273	3,391	3,751
From district IV to district V:														
Gasoline (motor)	835	733	922	825	1,051	959	875	848	850	832	749	867	10,346	10,540
Jet fuel:														
Naphtha-type	38	34	86	64	95	73	87	67	41	62	72	57	776	862
Kerosine-type	52	16	81	60	30	116	56	53	24	55	57	3	603	704
Total jet fuel	90	50	167	124	125	189	143	120	65	117	129	60	1,379	1,566
Distillate fuel oil	473	377	293	355	407	307	330	373	425	301	330	358	4,329	4,851

Table 47.—Transportation of petroleum products by pipelines in the United States in 1975, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1975	Total 1974
Turned into lines:														
Gasoline:														
Motor	146,026	135,561	146,819	144,977	151,463	155,778	165,150	164,160	153,600	151,184	148,653	155,623	1,818,994	1,769,418
Aviation	376	190	289	248	260	258	311	407	378	489	342	288	3,836	4,533
Total gasoline	146,402	135,751	147,108	145,225	151,723	156,036	165,461	164,567	153,978	151,673	148,995	155,911	1,822,830	1,773,951
Jet fuel:														
Naphtha-type	2,272	2,529	2,893	3,116	2,720	2,679	2,548	3,013	3,272	3,493	2,690	2,815	34,040	33,229
Kerosine-type	20,023	17,023	18,053	17,767	18,530	18,329	18,500	19,790	20.605	19,507	18,728	18,683	225,538	215,086
Total jet fuel	22,295	19,552	20,946	20,883	21,250	21,008	21,048	22,803	23,877	23,000	21,418	21,498	259,578	248,315
Kerosine	4,163	3,810	3,009	2,449	1,627	1,059	1,736	1,801	1,900	2,855	2,484	3,971	30,864	35,941
Distillate fuel oil	71,187	59,372	56,660	52,413	49,842	46,395	50,467	51,713	53,855	57,987	53,871	63,296	667,058	701,798
Natural gas liquids	44,125	36,688	40,019	37,843	40,485	40,778	41,234	41,720	42,672	45,414	44,795	48,941	504,714	467,280
Delivered from lines:														
Gasoline:														
Motor	144,286	133,816	145,581	146,167	153,396	157,523	165,078	163,195	152,087	152,394	147,132	156,555	1,817,210	1,770,174
Aviation	331	283	256	205	268	271	409	349	378	401	367	332	3,850	4,324
Total gasoline	144,617	134,099	145,837	146,372	153,664	157,794	165,487	163,544	152,465	152,795	147,499	156,887	1,821,060	1,774,498
Jet fuel:														
Naphtha-type	2,487	2,502	2,813	2,991	2,916	2,669	2,610	2,923	3,045	3,496	2,977	2,698	34,127	33,044
Kerosine-type	20,252	16,136	18,022	17,806	18,106	17,803	18,642	19,202	19,538	19,485	18,860	18,139	221,991	211,675
Total jet fuel	22,739	18,638	20,835	20,797	21,022	20,472	21,252	22,125	22,583	22,981	21,837	20,837	256,118	244,719
Kerosine	4,142	3,912	3,112	2,070	1,602	1,129	1,649	1,443	1,914	2,629	2,328	3,756	29,686	35,822
Distillate fuel oil	72,689	62,549	59,501	52,765	50,773	46,725	48,602	50,126	50,851	56,523	53,886	63,047	668,037	701,650
Natural gas liquids	44,021	37,424	40,626	38,379	39,001	39,945	41,471	40,139	42.003	44,563	42,024	47,692	497,288	468,567
Shortage or overage:[1]														
Gasoline:														
Motor	133	823	(634)	(399)	(328)	381	(180)	503	(91)	(305)	(478)	(765)	(1,340)	(1,010)
Aviation	35	(4)	9	11	7	15	(65)	(1)	15	13	16	31	82	145
Total gasoline	168	819	(625)	(388)	(321)	396	(245)	502	(76)	(292)	(462)	(734)	(1,258)	(865)
Jet fuel:														
Naphtha-type	(23)	78	(3)	50	(127)	18	8	62	(50)	(2)	24	(14)	21	(135)
Kerosine-type	173	229	274	329	366	204	250	176	451	270	358	154	3,234	3,340
Total jet fuel	150	307	271	379	239	222	258	238	401	268	382	140	3,255	3,205
Kerosine	162	145	102	107	66	70	121	62	52	118	114	109	1,228	884
Distillate fuel oil	(206)	1,028	(1,095)	207	(134)	29	186	(40)	(164)	78	8	(468)	(571)	(553)
Natural gas liquids	71	23	352	136	122	790	463	606	668	1,350	1,456	1,033	7,070	(299)

Stocks in lines and working tanks at end of month:														
Gasoline:														
Motor	46,828	47,750	49,622	48,831	47,226	45,100	45,352	45,814	47,418	46,513	48,512	48,345	48,345	45,221
Aviation	263	174	198	230	215	187	154	213	198	273	232	157	157	253
Total gasoline	47,091	47,924	49,820	49,061	47,441	45,287	45,506	46,027	47,616	46,786	48,744	48,502	48,502	45,474
Jet fuel:														
Naphtha-type	704	653	736	811	742	734	664	692	969	968	657	788	788	896
Kerosine-type	4,916	5,574	5,331	4,963	5,021	5,343	4,951	5,363	5,979	5,731	5,241	5,631	5,631	5,318
Total jet fuel	5,620	6,227	6,067	5,774	5,763	6,077	5,615	6,055	6,948	6,699	5,898	6,419	6,419	6,214
Kerosine	1,731	1,484	1,279	1,551	1,510	1,370	1,336	1,632	1,566	1,674	1,716	1,822	1,822	1,872
Distillate fuel oil	31,819	27,614	25,868	25,309	24,512	24,153	25,832	27,459	30,627	32,013	31,990	32,707	32,707	33,115
Natural gas liquids	20,610	19,851	18,892	18,220	19,582	19,625	18,925	19,900	19,901	19,402	20,717	20,933	20,933	20,577

[1] Figures in parentheses denote shortage.

Table 48.—Pipeline tariff rates for crude petroleum and petroleum products, January 1

(Cents per barrel)

Origin	Destination	1975	1976
Crude oil:			
West Texas	Houston, Tex	28	28
Do	East Chicago, Ind	36	39
Do	Wood River, Ill	36	39
Oklahoma	Chicago, Ill	26	29
Do	Wood River, Ill	21	21
Eastern Wyoming	Chicago, Ill	38	38
Do	Wood River, Ill	35	35
Refined products:			
Houston, Tex	Atlanta, Ga	53	58
Do	New York, N.Y.	45	52
Tulsa, Okla	Minneapolis, Minn	77	85
Salt Lake City, Utah	Spokane, Wash	54	52
Philadelphia, Pa	Rochester, N.Y	45	50

Source: Interstate Commerce Commission.

Table 49.—Stocks of crude petroleum, natural gas liquids, and refined products in the United States at yearend

(Thousand barrels)

	1971	1972	1973	1974	1975
Crude petroleum:					
At refineries	73,115	70,327	76,971	83,214	86,761
Pipeline and tank farm	172,309	162,476	152,533	168,944	172,610
Producers	14,224	13,592	12,974	12,862	11,983
Total crude petroleum	259,648	246,395	242,478	265,020	271,354
Unfinished oils	100,574	94,761	99,154	106,031	106,352
Natural gasoline [1]	5,163	4,802	6,160	6,480	6,217
Plant condensate	1,013	1,273	1,675	1,070	1,165
Refined products	677,549	611,748	658,840	695,045	747,867
Grand total	1,043,947	958,979	1,008,307	1,073,646	1,132,955

[1] Includes isopentane.

Table 50.—Stocks of crude petroleum in the United States in 1975, by State of origin and month

(Thousand barrels)

State of origin	Jan. 1	Jan. 31	Feb. 28	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
Alabama	71	67	68	99	210	329	428	465	302	223	462	326	375
Alaska	4,579	4,534	4,122	3,710	3,838	3,508	3,510	3,100	3,532	3,819	3,425	4,015	4,502
Arizona	77	92	84	86	75	83	79	85	92	86	92	80	86
Arkansas	853	798	784	742	821	701	1,095	916	734	753	702	1,303	1,440
California	23,201	22,290	23,047	25,207	26,170	25,293	24,128	24,202	25,852	24,041	25,124	24,784	23,727
Colorado	3,005	3,145	3,348	3,514	3,366	3,678	3,364	3,265	2,768	2,638	2,683	2,586	2,911
Florida	2,188	3,576	3,273	3,150	2,640	2,878	2,864	2,590	2,587	2,916	2,543	2,685	3,149
Illinois	3,585	3,359	3,120	3,366	3,175	3,149	3,679	3,610	2,693	2,479	3,272	2,877	3,517
Indiana	675	654	580	639	698	695	719	648	589	601	668	696	712
Kansas	5,994	6,035	6,786	5,805	6,026	5,822	5,237	4,910	4,985	5,263	5,278	5,233	5,421
Kentucky	398	556	494	507	544	532	439	556	452	342	379	398	890
Louisiana	29,398	28,678	30,486	29,751	29,823	29,845	29,763	29,619	26,571	26,870	30,224	30,203	26,952
Michigan	1,076	1,215	1,322	1,296	1,590	1,318	1,263	1,538	1,537	1,926	1,830	1,499	1,783
Mississippi	2,591	2,706	3,120	2,910	3,268	3,009	2,744	2,918	2,506	2,539	2,251	2,516	2,323
Missouri	--	--	--	--	--	--	--	--	--	--	--	1	4
Montana	2,709	2,793	2,835	2,831	2,628	3,112	2,816	2,681	2,688	2,934	2,675	2,084	2,314
Nebraska	584	462	327	511	486	442	526	513	580	671	1,030	907	1,015
New Mexico	7,746	8,149	6,693	7,329	7,719	7,656	7,737	7,521	7,422	7,559	7,931	8,084	8,137
New York	30	73	30	30	74	45	36	30	30	30	30	40	38
North Dakota	1,546	1,455	1,526	1,602	1,587	1,599	1,578	1,598	1,736	1,753	1,740	1,663	1,680
Ohio	1,007	1,105	962	1,029	1,244	1,118	1,128	1,181	990	982	1,000	1,160	1,274
Oklahoma	12,954	14,048	14,393	14,213	14,410	15,047	13,963	13,345	13,273	12,943	14,492	14,471	15,309
Pennsylvania	466	562	573	501	564	689	730	687	745	733	590	476	564
South Dakota	--	--	--	1	1	1	--	--	1	1	1	2	1
Texas	94,986	94,914	97,120	99,518	100,569	97,617	95,599	90,040	86,692	87,044	89,721	91,567	91,883
Utah	3,380	3,199	2,985	3,189	3,083	3,381	3,610	3,557	3,499	3,491	3,340	3,830	3,888
West Virginia	697	636	750	738	616	701	596	656	610	681	721	637	711
Wyoming	17,026	16,850	17,191	18,953	20,470	20,879	20,676	18,658	18,099	18,536	18,295	18,121	19,065
Total domestic crude	220,822	221,951	226,019	231,227	235,695	233,127	228,307	218,889	211,565	211,854	220,499	222,244	223,671
Foreign crude:													
Districts I–IV	30,991	34,900	37,113	35,778	33,812	35,102	34,483	32,176	33,492	35,973	35,978	34,543	34,255
District V	13,207	13,611	13,623	12,984	12,401	12,732	13,342	13,092	11,559	11,619	13,107	14,163	13,428
Total foreign crude	44,198	48,511	50,736	48,762	46,213	47,834	47,825	45,268	45,051	47,592	49,085	48,706	47,683
Total crude stocks	265,020	270,462	276,755	279,989	281,908	280,961	276,132	264,157	256,616	259,446	269,584	270,950	271,354
Pennsylvania grade (included in "Total domestic crude")	1,777	2,017	1,353	1,887	2,064	2,119	1,429	2,113	2,003	2,062	1,954	1,943	2,176

Table 51.—Stocks of crude petroleum in the United States in 1975, by State and month

(Thousand barrels)

State	Jan. 1	Jan. 31	Feb. 28	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
Alabama	1,353	1,110	1,302	1,162	985	1,009	1,337	1,178	1,048	1,150	1,243	1,303	1,488
Alaska, Arizona, Hawaii, Nevada, Oregon, Washington	6,850	6,525	7,848	7,224	5,596	6,888	6,195	5,599	6,039	5,219	5,902	7,799	6,864
Arkansas	1,405	1,351	1,334	1,263	1,373	1,253	1,645	1,463	1,283	1,301	1,263	1,857	1,996
California	35,536	35,444	34,161	26,218	38,282	36,183	36,350	36,318	36,380	35,768	37,031	36,721	36,069
Colorado	1,612	1,618	1,759	1,700	1,879	1,897	1,812	1,747	1,384	1,468	1,537	1,292	1,647
Delaware and Maryland	1,239	1,597	1,570	1,998	1,456	1,477	1,344	1,649	2,110	1,853	609	1,505	964
Florida, Georgia, Virginia, West Virginia	2,406	2,904	3,071	2,490	2,099	2,678	2,519	2,026	1,962	2,278	2,412	2,029	2,112
Illinois	18,032	17,684	18,564	18,642	18,629	18,698	18,106	17,325	15,841	16,974	20,452	19,839	19,842
Indiana	3,215	3,518	3,171	3,373	3,853	3,648	3,578	3,898	3,735	3,710	4,049	4,191	3,809
Iowa, Missouri, Nebraska	7,683	7,588	7,865	8,037	8,368	8,602	8,015	7,633	7,630	7,864	8,512	7,480	7,408
Kansas	9,736	9,953	10,630	10,721	10,781	10,959	9,838	9,581	9,253	9,411	9,573	9,970	10,447
Kentucky and Tennessee	4,878	4,604	4,027	4,094	4,557	4,656	4,425	4,722	4,316	3,668	4,198	4,229	4,276
Louisiana	18,979	20,492	21,614	22,236	21,319	21,976	21,763	21,036	21,155	21,478	21,887	22,378	21,365
Michigan	2,301	2,543	2,581	2,437	2,735	2,393	2,452	2,468	2,293	2,731	2,766	2,600	2,566
Minnesota and Wisconsin	3,833	3,920	4,119	3,757	3,455	2,366	2,921	3,123	3,454	2,942	3,389	3,562	3,509
Mississippi	4,760	5,730	5,251	5,488	4,711	5,564	6,194	5,896	5,869	5,349	5,661	5,372	4,601
Montana	3,044	3,001	3,042	2,696	2,566	3,178	2,954	2,763	2,884	2,815	2,742	3,010	3,103
New Hampshire, New York, Rhode Island	722	716	762	521	569	642	591	459	440	706	857	668	1,127
New Jersey	4,322	5,824	5,895	5,785	7,090	5,798	5,629	5,018	4,463	4,726	5,472	4,814	5,086
New Mexico	4,520	4,487	4,542	4,430	4,900	4,821	4,694	4,542	4,482	4,105	4,075	4,115	3,865
North Dakota and South Dakota	929	1,186	1,274	1,243	1,278	1,317	1,353	1,344	1,387	1,336	1,331	1,288	1,304
Ohio	7,761	6,360	6,934	7,384	8,175	7,088	7,321	7,135	6,163	7,123	7,377	6,597	7,978
Oklahoma	21,185	22,447	19,209	21,468	20,862	20,111	19,459	18,585	18,555	17,264	18,411	19,624	21,905
Pennsylvania	8,175	8,709	7,891	8,760	8,036	9,587	8,462	7,095	7,680	7,535	7,699	6,585	6,582
Texas	79,393	80,040	86,562	84,120	86,025	85,265	83,946	79,460	76,710	80,215	80,375	81,100	79,542
Utah	1,606	1,498	1,454	1,656	1,491	1,645	1,630	1,588	1,447	1,502	1,503	1,566	1,568
Wyoming	9,545	9,613	10,323	11,086	10,838	11,262	11,599	10,506	8,653	8,955	9,258	9,456	10,331
Total	265,020	270,462	276,755	279,989	281,908	280,961	276,132	264,157	256,616	259,446	269,584	270,950	271,354

Table 52.—Stocks of crude petroleum in the United States in 1975, by classification, State, and month

(Thousand barrels)

Classification and State	Jan. 1	Jan. 31	Feb. 28	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
At refineries:													
Alabama	143	148	249	306	224	226	333	366	296	190	223	238	256
Alaska, Arizona, Hawaii, Nevada, Oregon, Washington	4,639	4,599	5,953	5,914	4,138	4,889	4,626	4,375	4,279	3,417	3,631	5,608	4,918
Arkansas	109	119	118	131	174	159	142	114	130	177	121	161	96
California	19,654	20,685	18,989	19,441	20,529	19,854	21,167	21,107	20,534	19,698	19,627	19,845	19,675
Colorado	244	311	386	378	322	373	278	290	243	193	233	258	239
Delaware and Maryland	1,239	1,597	1,570	1,998	1,456	1,477	1,344	1,649	2,110	1,853	609	1,505	964
Florida, Georgia, Virginia, West Virginia	1,707	1,887	2,073	1,527	1,286	1,657	1,483	1,154	1,316	1,435	1,442	1,306	1,239
Illinois	4,506	5,081	4,974	4,719	4,733	4,352	4,234	4,691	3,985	4,538	5,322	5,406	5,092
Indiana	1,128	1,240	1,133	1,180	1,409	1,231	1,090	1,182	1,178	1,195	1,357	1,447	1,408
Iowa, Missouri, Nebraska	320	355	330	335	275	291	309	316	291	294	287	352	327
Kansas	1,801	1,757	1,772	1,649	1,731	1,839	1,860	1,474	1,210	1,548	1,528	1,698	1,607
Kentucky and Tennessee	1,039	884	710	890	1,056	904	1,008	1,049	1,160	865	1,101	1,070	960
Louisiana	6,844	8,540	8,586	8,857	8,219	9,351	9,152	8,551	8,520	8,895	8,982	9,126	8,956
Michigan	721	765	853	720	784	565	696	667	476	623	783	768	1,018
Minnesota and Wisconsin	1,784	1,926	2,025	1,558	1,431	1,154	1,130	1,403	1,391	1,381	1,388	1,602	1,549
Mississippi	1,051	1,720	1,393	1,561	804	1,671	1,970	1,938	2,124	1,853	2,604	1,631	1,287
Montana	935	923	924	767	713	1,063	1,080	1,006	962	758	753	587	585
New Hampshire, New York, Rhode Island	550	456	531	234	308	393	392	390	371	484	627	428	889
New Jersey	4,322	5,824	5,895	5,785	7,090	5,798	5,629	5,018	4,463	4,726	5,472	4,814	5,086
New Mexico	541	602	745	672	735	623	658	458	508	459	484	502	493
North Dakota and South Dakota	160	209	215	259	290	341	315	319	326	281	281	249	266
Ohio	2,401	1,984	2,033	1,750	2,587	1,956	2,217	2,415	2,155	2,234	2,074	2,132	2,109
Oklahoma	1,704	1,812	1,765	1,742	2,017	1,819	1,538	1,546	1,813	1,643	1,729	1,823	1,765
Pennsylvania	7,487	8,015	7,190	8,088	7,312	8,655	7,620	6,054	6,599	6,486	7,023	6,029	5,669
Texas	16,641	18,963	22,939	21,049	21,516	21,947	20,872	20,026	18,097	20,542	20,197	19,697	18,551
Utah	625	560	531	677	683	784	732	557	557	619	576	582	643
Wyoming	919	873	927	797	945	1,106	1,093	924	1,006	780	1,000	1,170	1,114
Total at refineries	83,214	91,835	94,809	92,984	92,767	94,478	92,968	89,039	86,100	87,167	89,454	90,034	86,761
Pipeline and tank farm stocks:													
Alabama	1,199	949	1,034	840	738	759	979	791	726	941	1,002	1,039	1,205
Alaska, Arizona, Hawaii, Nevada, Oregon, Washington	2,154	1,864	1,840	1,239	1,390	1,929	1,508	1,169	1,703	1,745	2,219	2,131	1,889
Arkansas	1,225	1,161	1,145	1,061	1,175	1,026	1,435	1,282	1,068	1,053	1,071	1,625	1,829
California	14,550	13,533	13,870	15,601	16,436	14,955	13,816	13,795	14,393	14,791	16,226	15,507	15,169
Colorado	1,157	1,128	1,203	1,147	1,365	1,344	1,351	1,274	964	1,092	1,128	858	1,209
Florida, Georgia, Virginia, West Virginia	495	804	793	758	589	796	823	655	426	624	751	561	658
Illinois	13,369	12,363	13,347	13,673	13,651	14,103	13,047	12,547	11,789	12,368	15,065	14,362	14,680
Indiana	2,054	2,245	1,989	2,142	2,389	2,361	2,433	2,662	2,503	2,461	2,638	2,690	2,348

Table 52.—Stocks of crude petroleum in the United States in 1975, by classification, State, and month—Continued

(Thousand barrels)

Classification and State	Jan. 1	Jan. 31	Feb. 28	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
Pipeline and tank farm stocks—Continued													
Iowa, Missouri, Nebraska	7,262	7,132	7,436	7,601	7,992	8,213	7,607	7,220	7,240	7,471	8,126	7,028	6,977
Kansas	7,725	8,012	8,665	8,886	8,866	8,938	7,773	7,926	7,863	7,683	7,862	8,085	8,653
Kentucky and Tennessee	3,786	3,667	3,263	3,150	3,425	3,675	3,341	3,596	3,079	2,724	3,028	3,090	3,269
Louisiana	9,804	9,704	10,837	11,088	10,726	10,396	10,336	10,195	10,461	10,317	10,764	11,020	10,209
Michigan	1,490	1,682	1,634	1,611	1,855	1,733	1,657	1,702	1,718	2,009	1,884	1,720	1,423
Minnesota and Wisconsin	2,049	1,994	2,094	2,199	2,024	1,212	1,791	1,720	2,063	1,561	2,001	1,960	1,960
Mississippi	3,491	3,806	3,642	3,711	3,698	3,674	4,015	3,749	3,506	3,269	2,856	3,513	3,127
Montana	1,788	1,749	1,783	1,594	1,493	1,762	1,521	1,426	1,573	1,713	1,653	2,062	2,192
New Hampshire, New York, Rhode Island	142	230	201	257	231	219	169	39	39	192	200	210	208
New Mexico	3,095	3,060	2,938	2,953	3,311	3,354	3,204	3,305	3,160	2,848	2,793	2,813	2,578
North Dakota and South Dakota	715	926	1,009	930	933	925	985	986	1,007	1,001	978	968	968
Ohio	5,285	4,301	4,826	5,559	5,513	5,057	5,029	4,645	3,933	4,814	5,228	4,390	5,794
Oklahoma	18,562	19,842	16,624	18,895	18,213	17,458	17,043	16,161	15,852	14,725	15,795	16,880	19,240
Pennsylvania	540	546	554	522	574	781	695	895	935	903	583	498	820
Texas	58,036	56,598	59,133	58,559	59,905	58,700	58,634	55,339	54,357	55,476	55,981	57,037	56,743
Utah	823	763	751	797	639	690	722	850	718	703	753	797	747
Wyoming	8,148	8,269	8,928	9,807	9,396	9,649	9,991	9,067	7,149	7,677	7,760	7,788	8,715
Total at pipelines and tank farms	168,944	166,328	169,539	174,580	176,527	173,709	169,905	162,996	158,225	160,161	168,345	168,632	172,610
Lease stocks	12,862	12,299	12,407	12,425	12,614	12,774	13,259	12,122	12,291	12,118	11,785	12,284	11,983
Total stocks:													
1975	265,020	270,462	276,755	279,989	281,908	280,961	276,132	264,157	256,616	259,446	269,584	270,950	271,354
1974	242,478	233,035	240,723	244,665	256,385	269,455	268,765	268,686	264,840	266,726	269,437	271,144	265,020

Table 53.—Stocks of refined petroleum products (including unfinished oils) in the United States at end of month

(Thousand barrels)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1974												
Gasoline:												
Motor	217,542	219,105	220,347	223,805	218,711	217,421	218,889	219,004	227,070	220,797	218,444	218,410
Aviation	3,785	3,885	3,234	3,024	3,168	3,094	3,273	3,057	3,646	3,347	3,457	3,471
Total	221,327	222,990	223,581	226,829	221,879	220,515	222,162	222,061	230,716	224,144	221,901	221,881
Jet fuel:												
Naphtha-type	5,828	6,069	6,711	6,837	6,701	6,677	6,436	5,742	5,779	5,606	5,883	5,529
Kerosine-type	23,904	23,548	23,285	24,888	25,623	25,523	25,235	25,247	24,407	24,958	23,733	23,906
Total	29,732	29,617	29,996	31,725	32,324	32,200	31,671	30,989	30,186	30,564	29,616	29,435
Ethane (including ethylene)	4,747	4,451	4,533	4,644	5,185	5,424	5,423	5,319	5,088	4,945	4,560	4,562
Liquefied gases [1]	85,332	84,049	88,372	94,803	104,168	111,204	118,982	125,392	126,169	123,987	117,831	107,980
Kerosine	17,486	15,609	15,001	14,873	16,579	17,315	17,195	17,086	17,079	16,999	16,707	15,269
Distillate fuel oil	181,217	149,162	128,852	125,587	141,843	160,680	182,495	198,710	208,308	209,945	212,913	200,068
Residual fuel oil	46,548	45,004	47,222	51,339	54,356	57,891	59,787	60,988	60,251	58,679	60,363	59,694
Petrochemical feedstocks	2,206	2,662	2,733	2,666	2,912	3,177	3,195	3,104	2,980	3,082	3,298	3,486
Special naphthas	4,556	4,462	4,595	4,627	4,872	4,901	4,944	4,959	5,001	5,033	5,393	5,720
Lubricants	12,016	12,343	12,729	12,957	12,744	13,956	13,796	14,422	14,698	14,861	15,414	16,060
Wax	909	922	868	904	945	1,006	997	1,077	1,114	1,139	1,147	1,195
Coke	9,642	9,057	8,266	7,756	7,455	6,898	6,572	6,354	6,532	6,472	6,217	5,420
Asphalt	17,961	20,145	23,153	25,443	25,778	24,540	22,702	20,238	17,278	15,407	17,005	21,370
Road oil	918	1,115	1,502	1,751	1,979	1,866	1,738	1,645	1,398	1,008	879	1,080
Miscellaneous	1,533	1,633	1,854	2,370	2,271	2,015	1,542	1,604	1,682	1,579	1,719	1,825
Unfinished oils	97,862	95,077	106,861	109,501	116,748	118,720	116,727	113,223	109,554	110,002	109,136	106,031
Total	733,992	698,298	700,118	717,775	752,038	782,308	809,928	827,171	838,034	827,846	824,099	801,076
1975 p												
Gasoline:												
Motor	242,340	251,974	248,749	232,619	213,997	207,155	212,504	215,512	226,478	221,532	232,139	234,978
Aviation	3,602	3,462	3,345	3,048	3,031	2,859	2,737	2,863	2,757	2,922	3,140	3,024
Total	245,942	255,436	252,094	235,667	217,028	210,014	215,241	218,375	229,235	224,454	235,279	238,002
Jet fuel:												
Naphtha-type	5,548	5,415	6,155	5,777	5,484	5,253	5,578	5,654	5,797	5,864	5,812	5,222
Kerosine-type	24,773	23,718	24,301	24,486	25,235	24,084	24,220	25,449	25,494	24,546	23,165	25,158
Total	30,321	29,133	30,456	30,263	30,719	29,337	29,798	31,103	31,291	30,410	28,977	30,380
Ethane (including ethylene)	4,709	4,969	5,390	5,619	6,130	7,080	7,330	7,317	6,778	6,389	6,725	7,014
Liquefied gases [1]	98,062	93,509	91,738	95,775	105,539	117,033	123,914	131,152	134,845	135,183	131,358	118,134
Kerosine	16,466	15,348	15,170	15,255	16,512	15,351	16,038	17,153	17,775	17,772	18,237	15,571
Distillate fuel oil	199,752	176,734	161,149	146,257	152,070	163,348	181,514	197,364	220,776	226,160	235,798	208,833
Residual fuel oil	69,233	66,495	64,148	66,340	73,498	69,660	71,526	71,857	76,938	81,858	83,131	74,126
Petrochemical feedstocks	3,888	3,459	3,308	3,475	3,047	2,847	2,651	2,705	3,025	2,739	2,987	2,924
Special naphthas	5,535	5,317	5,606	5,173	5,046	5,000	4,469	4,360	4,481	4,302	4,366	4,377
Lubricants	15,659	15,543	16,486	16,045	15,406	14,896	14,725	14,159	13,981	13,343	14,178	14,337
Wax	1,088	1,014	969	976	947	959	951	912	807	743	817	861
Asphalt	5,384	5,448	5,712	5,955	6,053	6,078	6,415	6,627	7,177	7,386	7,825	7,360
Coke	24,899	26,932	30,238	30,713	31,603	29,561	28,410	26,274	22,626	19,755	20,179	22,794
Road oil	1,258	1,437	1,602	1,676	1,669	1,859	834	722	687	672	597	571
Miscellaneous	1,699	1,902	1,849	1,998	1,982	2,057	2,103	2,109	2,870	2,935	2,628	2,583
Unfinished oils	97,488	99,182	103,345	107,071	113,922	111,605	108,580	110,759	107,874	106,827	108,767	106,352
Total	820,883	801,858	789,260	768,258	781,171	786,685	814,499	842,948	880,666	879,428	901,849	854,219

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[1] Includes LRG used for petrochemical feedstocks.

Table 54.—Value of crude petroleum at wells in the United States, by State

State	1974 Total value at wells (thousands)	1974 Average value per barrel	1975 Total value at wells (thousands)	1975 Average value per barrel
Alabama	$113,808	$8.54	$136,541	$10.13
Alaska	347,408	4.92	364,630	5.22
Arizona	3,885	5.25	3,332	5.25
Arkansas	122,817	7.43	143,336	8.88
California	1,710,350	5.30	1,943,048	6.03
Colorado	283,904	7.57	365,654	9.60
Florida	351,331	9.66	490,258	11.71
Illinois	244,395	8.87	273,182	10.48
Indiana	42,402	8.62	48,821	10.54
Kansas	490,984	7.96	561,508	9.50
Kentucky	68,340	8.72	84,520	11.19
Louisiana:				
Gulf Coast	4,551,481	6.52	4,358,452	7.10
Northern	260,291	6.70	253,427	6.79
Total Louisiana	4,811,772	6.53	4,611,879	7.09
Michigan	154,746	8.59	262,352	10.74
Mississippi	309,753	6.10	310,346	6.66
Montana	229,802	6.65	257,169	7.83
Nebraska	45,167	6.83	55,133	9.01
New Mexico:				
Southeastern	656,898	7.24	734,204	8.29
Northwestern	55,680	6.96	53,869	8.29
Total New Mexico	712,578	7.22	788,073	8.29
New York	9,538	10.65	10,693	12.22
North Dakota	119,022	6.04	149,705	7.32
Ohio	89,348	9.83	113,917	11.89
Oklahoma	1,277,076	7.18	1,389,164	8.52
Pennsylvania	36,220	10.41	39,647	12.15
South Dakota	3,283	6.65	5,996	12.70
Tennessee	7,256	9.44	7,849	11.51
Texas:				
Gulf Coast	1,826,100	7.41	1,866,358	7.96
East Texas field	508,302	7.04	533,269	7.73
West Texas	4,507,693	6.76	4,925,842	7.47
Panhandle	149,156	7.00	159,887	7.76
Rest of State	1,781,752	7.00	1,851,214	7.76
Total Texas	8,773,003	6.95	9,336,570	7.64
Utah	279,858	7.11	348,131	8.23
West Virginia	27,058	10.15	29,712	11.99
Wyoming	914,360	6.53	983,785	7.24
Other States [1]	1,085	5.77	1,108	6.33
Total United States	21,580,549	6.74	23,116,059	7.56

[1] Missouri, Nevada, and Virginia.

Table 55.—Posted price per barrel of petroleum at wells in the United States in 1975, by grade [1]

Grade	Price per barrel
Pennsylvania grade:	
Bradford and Allegheny districts	$6.83
Southwest Pennsylvania	6.12
Corning grade	5.17
Western Kentucky	5.20
Indiana-Illinois	5.20
Coldwater, Michigan	5.00
Oklahoma-Kansas:	
34°-34.9° API	5.11
36°-36.9° API	5.15
Texas, Panhandle (Carson, Gray, Hutchinson, and Wheeler Counties), 35°-35.9° API	5.10
West Texas, 30°-30.9° API (sweet)	5.11
Lea County, New Mexico, 30°-30.9° API (sour)	5.00
South Texas, Mirando, 24°-24.9° API	5.30
East Texas	5.20
Conroe, Texas	5.30
Texas:	
30°-30.9° API	5.05
20°-20.9° API	4.95
Louisiana, 30°-30.9° API	5.15
Caddo-Pine Island, Louisiana, 36°-36.9° API	5.04
Magnolia Smackover Limestone, Arkansas, 31°-31.9° API	4.84
Elk Basin, Wyoming (including Montana), 30°-30.9° API	4.86
California:	
Coalinga, 32°-32.9° API	5.01
Kettlemen Hills, 37°-37.9° API	5.26
Midway Sunset, 19°-19.9° API	4.28
Wilmington, 24°-24.9° API	4.63

[1] No price change listed in 1975.

Source: Platt's Oil Price Handbook and Oilmanac.

Table 56.—Wholesale price index, crude petroleum

(1967=100)

Month	1971	1972	1973	1974	1975
January	113.2	113.2	114.7	178.4	223.1
February	113.2	113.2	114.7	201.7	228.6
March	113.2	113.2	114.9	201.7	230.2
April	113.2	113.2	117.1	201.7	232.2
May	113.2	113.2	122.0	201.7	234.2
June	113.2	113.2	125.3	201.7	256.0
July	113.2	113.2	125.8	224.4	250.4
August	113.2	114.7	125.8	225.2	256.1
September	113.2	114.7	133.3	225.4	256.1
October	113.2	114.7	133.3	226.2	257.8
November	113.2	114.7	139.3	231.0	261.0
December	113.2	114.7	146.2	223.0	262.6
Average	113.2	113.8	126.0	211.8	245.6

Source: Bureau of Labor Statistics, U.S. Department of Labor.

Table 57.—Average monthly price of petroleum products in the United States, 1974–75

Monthly average and grade	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average for year
Gasoline, 92 octane, cents per gallon:														
At refineries in Oklahoma	1974	25.24	26.96	29.59	30.50	30.50	30.50	30.15	29.03	28.42	27.33	27.38	27.50	28.59
	1975	27.50	27.50	27.50	27.25	28.70	30.83	33.36	35.25	34.90	34.50	34.39	33.05	31.23
Tank wagon prices to dealers at 55 cities on first of month.	1974	25.06	28.20	28.08	29.70	31.36	32.89	32.42	33.07	32.85	30.54	30.80	31.45	30.54
	1975	32.07	32.09	32.56	33.24	34.41	35.60	36.88	38.64	38.64	38.64	38.38	38.16	35.78
At service station (including all taxes)	1974	44.82	48.04	50.08	51.61	53.71	55.55	55.59	55.71	55.04	52.91	52.66	53.15	52.41
	1975	53.98	53.94	54.18	54.50	55.55	56.91	59.17	59.83	59.83	59.87	59.42	59.42	57.22
Kerosine, cents per gallon:														
No. 1 range at Chicago district	1974	27.76	29.60	30.10	30.13	30.50	31.43	31.56	30.24	30.00	30.00	30.00	30.00	30.11
	1975	29.87	29.75	29.75	29.75	30.40	30.95	31.75	31.86	32.00	32.95	32.13	33.62	31.32
No. 1 fuel oil at Oklahoma	1974	23.70	23.94	24.70	26.07	26.13	26.93	28.38	27.39	27.25	27.25	27.25	27.25	26.35
	1975	27.00	26.75	26.75	26.25	27.23	27.73	28.88	29.13	29.13	29.75	29.75	30.31	28.22
Kerosine (or No. 1 fuel oil) at New York Harbor	1974	26.03	26.30	26.30	26.50	29.93	30.88	30.88	30.88	31.14	31.66	30.23	29.00	29.14
	1975	28.83	28.83	29.89	30.71	30.49	30.25	30.25	30.42	31.25	32.76	33.80	33.77	30.94
Kerosine (or No. 1 fuel oil) at Tampa	1974	17.40	23.60	23.60	23.60	27.27	28.38	28.89	28.98	28.08	28.36	27.74	27.55	26.12
	1975	28.11	27.80	29.02	28.73	29.18	27.68	28.39	30.62	31.53	32.06	32.53	32.20	29.82
Distillate and diesel fuel oil, cents per gallon:														
No. 2 fuel oil at refineries, Oklahoma	1974	22.89	22.94	23.70	25.07	25.13	25.93	27.38	26.39	26.25	26.25	26.25	26.25	25.37
	1975	26.00	25.75	25.75	25.25	26.23	26.73	27.88	28.13	28.13	28.75	28.75	29.31	27.22
No. 2 fuel oil at New York Harbor	1974	26.34	24.95	24.65	24.50	27.60	27.78	28.10	28.10	28.31	28.95	28.25	27.54	27.09
	1975	27.39	27.39	28.35	29.16	28.98	28.80	28.80	28.99	29.89	30.55	30.90	31.37	29.21
Marine diesel, dollars per barrel:														
New York Harbor	1974	16.36	16.36	16.36	16.18	15.45	15.45	15.45	15.45	r 15.45	r 15.35	r 14.99	r 14.99	r 15.64
	1975	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99	14.99
New Orleans	1974	16.36	16.36	16.36	16.18	15.45	15.45	15.45	15.45	15.45	15.28	15.12	15.12	15.67
	1975	15.12	15.12	15.12	15.12	15.12	15.12	15.12	15.12	15.12	15.12	15.12	15.12	15.12
San Francisco marine diesel	1974	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68
	1975	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68	15.68
Residual fuel oil, dollars per barrel:														
No. 6 fuel at refineries, Oklahoma	1974	4.38	4.38	5.62	8.62	8.85	8.85	8.85	8.85	8.85	8.85	8.85	8.85	7.82
	1975	8.85	8.85	8.85	8.85	8.85	8.85	8.85	8.85	8.45	8.00	8.00	8.00	8.60
No. 6 fuel oil at New York Harbor, maximum 0.3% sulfur.	1974	13.10	15.32	15.32	15.32	14.64	13.44	13.55	13.60	13.60	13.79	13.86	13.77	14.11
	1975	13.76	13.76	13.76	13.81	13.67	13.58	13.51	13.46	12.94	12.81	12.81	12.87	13.39
Bunker "C" for ships, dollars per barrel:														
New York	1974	8.00	10.91	10.99	10.99	10.77	10.63	10.69	10.69	10.69	10.99	11.09	11.09	10.63
	1975	11.09	11.33	11.56	11.56	11.56	11.68	11.73	11.25	11.13	11.11	10.79	10.58	11.28
New Orleans	1974	8.57	11.07	10.99	10.89	10.68	10.69	10.71	10.64	10.50	10.50	10.50	10.50	10.52
	1975	10.50	10.72	10.63	10.45	10.63	11.09	11.37	11.12	11.07	11.06	10.90	10.94	10.87
San Francisco	1974	11.74	11.88	10.98	11.38	11.47	11.47	11.47	11.40	11.37	10.77	10.05	10.05	11.17
	1975	10.05	10.05	10.22	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.48

Lubricating oil, cents per gallon:														
East Coast:														
200 viscosity at 100, 0–10 pour test, 95 V.I.	r 1974	33.01	38.00	42.65	43.75	43.75	44.88	45.75	45.75	45.75	46.20	46.75	46.75	43.58
	1975	46.75	46.75	46.75	46.75	46.75	46.75	46.75	46.75	46.75	46.75	46.75	46.75	46.75
500 viscosity at 100, 0–10 pour test, 95 V.I.	r 1974	40.23	40.50	46.11	47.50	47.50	48.63	49.50	49.50	49.50	49.95	50.50	50.50	47.49
	1975	50.50	50.50	50.50	50.50	50.50	50.50	50.50	50.50	50.50	50.50	50.50	50.50	50.50
South Texas: 500 viscosity No. 2½–3½ color	1974	29.52	35.00	38.68	39.50	39.50	40.63	41.50	41.50	41.50	41.50	41.50	41.50	39.32
	1975	41.50	41.50	41.50	41.50	41.50	41.50	41.50	41.50	41.50	41.50	42.30	42.50	41.65
Liquid petroleum gas (propane), cents per barrel:														
New York Harbor	1974	17.75	20.81	18.24	18.24	18.24	19.57	20.88	20.35	15.74	15.80	17.74	17.74	18.43
	1975	17.74	17.74	17.74	19.81	20.74	20.74	21.09	21.74	22.20	22.74	23.24	23.24	20.73
Oklahoma	1974	16.36	16.34	13.71	13.59	13.59	16.55	18.54	16.94	13.29	13.00	13.00	13.50	14.87
	1975	13.50	13.50	13.50	13.93	14.79	15.79	15.98	16.82	16.89	17.17	17.86	17.96	15.64
Baton Rouge	1974	16.57	16.12	13.50	13.48	13.48	16.67	19.28	19.02	15.64	15.67	16.64	16.64	16.06
	1975	16.64	16.64	16.64	17.21	16.98	16.62	17.84	19.17	19.53	19.65	20.68	20.75	18.19

r Revised.
Source: Platt's Oil Price Handbook and Oilmanac.

Table 58.—Petroleum oils, crude and refined, exported from the United States, including shipments, to territories and possesssions, by month [1]

(Thousand barrels)

Year and class	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1974													
Crude petroleum	534	281	--	15	200	44	--	--	--	--	--	--	1,074
Refined products:													
Gasoline: [2]													
Motor	126	18	225	41	10	11	21	172	15	17	13	196	865
Aviation	9	3	6	9	8	7	15	65	4	5	8	9	148
Total gasoline	135	21	231	50	18	18	36	237	19	22	21	205	1,013
Jet fuel:													
Naphtha-type	4	7	5	4	4	5	3	5	3	4	5	31	80
Kerosine-type	62	53	74	63	22	93	157	60	37	155	67	46	889
Total jet fuel	66	60	79	67	26	98	160	65	40	159	72	77	969
Liquefied gases:													
Butane	376	276	325	326	346	328	375	322	339	364	334	356	4,067
Propane	464	328	400	357	364	373	469	431	477	433	410	465	4,971
Total liquefied gases	840	604	725	683	710	701	844	753	816	797	744	821	9,038
Kerosine	3	--	3	5	7	2	4	2	3	4	--	3	36
Distillate fuel oil	125	108	204	41	27	34	84	17	41	15	55	104	855
Residual fuel oil	292	317	286	469	357	435	215	932	451	508	241	466	4,969
Petrochemical feedstocks	287	512	535	843	286	548	769	446	496	359	181	299	5,561
Special naphthas	127	131	99	117	135	139	85	118	72	131	81	65	1,300
Lubricants	1,023	676	1,021	1,206	1,184	1,020	1,279	1,010	799	918	988	812	11,936
Wax	54	62	114	75	63	72	78	91	36	55	61	118	879
Coke	2,806	2,837	2,597	3,524	4,436	3,891	4,147	3,873	2,252	3,787	3,012	4,082	41,244
Asphalt	20	14	57	69	72	31	51	26	14	12	23	21	410
Miscellaneous	96	57	113	136	122	119	97	94	87	80	115	91	1,207
Total refined	5,874	5,399	6,064	7,285	7,443	7,108	7,849	7,664	5,126	6,847	5,594	7,164	79,417
Total crude and refined	6,408	5,680	6,064	7,300	7,643	7,152	7,849	7,664	5,126	6,847	5,594	7,164	80,491

1975 p													
Crude petroleum	836	942	349	19	--	--	--	--	--	--	--	--	2,146
Refined products:													
Gasoline: [2]													
Motor	17	266	26	38	14	22	39	13	5	32	27	245	744
Aviation	9	4	3	5	8	11	9	6	5	10	5	31	106
Total gasoline	26	270	29	43	22	33	48	19	10	42	32	276	850
Jet fuel:													
Naphtha-type	--	--	--	--	--	--	--	--	--	--	--	--	--
Kerosine-type	59	62	43	39	68	39	69	52	45	44	41	49	610
Total jet fuel	59	62	43	39	68	39	69	52	45	44	41	49	610
Liquefied gases:													
Butane	429	384	550	424	381	315	315	368	365	384	327	394	4,636
Propane	496	463	439	446	403	352	398	373	343	384	327	428	4,852
Total liquefied gases	925	847	989	870	784	667	713	741	708	768	654	822	9,488
Kerosine	3	2	--	12	1	6	2	4	--	12	4	6	52
Distillate fuel oil	2	50	1	51	7	48	11	49	1	1	10	36	267
Residual fuel oil	463	528	295	178	246	619	540	371	577	164	376	985	5,342
Petrochemical feedstocks	377	406	696	839	549	627	638	1,139	893	528	478	867	8,037
Special naphthas	140	151	55	47	118	94	103	90	112	104	72	135	1,221
Lubricants	820	767	587	686	955	740	860	710	652	1,060	558	716	9,111
Wax	30	28	70	33	77	40	71	47	58	64	41	48	607
Coke	3,283	2,803	3,359	2,762	3,334	3,710	2,549	2,968	3,020	2,809	2,607	4,049	37,253
Asphalt	27	19	31	27	21	35	29	29	22	21	28	31	320
Miscellaneous	79	69	102	107	93	75	123	70	61	179	76	90	1,124
Total refined	6,234	6,002	6,257	5,694	6,275	6,733	5,756	6,289	6,159	5,796	4,977	8,110	74,282
Total crude and refined	7,070	6,944	6,606	5,713	6,275	6,733	5,756	6,289	6,159	5,796	4,977	8,110	76,428

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1 Compiled from records of U.S. Department of Commerce.
2 Includes benzol, natural gasoline, and antiknock compounds.

Table 59.—Crude oil and petroleum products exported from the United States, by country of destination

(Thousand barrels)

	Crude oil	Gasoline	Special naphthas	Jet fuel	Kerosine	Distillate oil	Residual oil	Lubricating oil	Asphalt	Liquefied petroleum gases	Wax	Coke	Petrochemical feedstocks	Miscellaneous products	Total
1974															
North America:															
Canada	108	27	326	516	4	114	2,674	1,446	68	99	87	5,185	759	199	11,612
Mexico	--	536	105	138	1	168	1,558	163	173	8,887	112	962	51	31	12,885
Total	108	563	431	654	5	282	4,232	1,609	241	8,986	199	6,147	810	230	24,497
Central America and Caribbean:															
Bahamas	966	7	8	2	(1)	12	11	30	1	1	(1)	--	(1)	(1)	1,038
British West Indies	--	--	(1)	--	--	--	(1)	2	1	(1)	(1)	--	(1)	(1)	3
Jamaica	--	--	2	--	--	1	(1)	165	2	1	1	(1)	1	1	174
Netherlands Antilles	--	--	1	--	--	--	(1)	19	(1)	(1)	(1)	--	(1)	(1)	20
Panama	--	(1)	1	--	--	--	--	51	1	--	3	24	2	--	82
Puerto Rico	--	171	34	--	2	175	51	596	5	5	20	451	2	8	1,520
Trinidad	--	10	--	--	--	--	(1)	43	1	--	1	--	(1)	1	56
Virgin Islands	--	56	1	--	2	(1)	519	43	20	(1)	(1)	--	(1)	(1)	641
Others	--	3	39	2	(1)	11	4	266	10	27	48	1	18	26	455
Total	966	247	86	4	4	199	585	1,215	41	34	73	476	23	36	3,989
South America:															
Argentina	--	(1)	8	--	(1)	--	(1)	27	1	--	4	--	1	3	44
Brazil	--	(1)	148	--	--	--	44	1,902	2	3	35	436	462	169	3,201
Chile	--	1	1	--	--	--	7	214	--	--	6	--	1	11	241
Ecuador	--	--	1	--	--	--	--	26	1	--	2	--	3	5	38
Peru	--	1	4	--	1	(1)	30	79	(1)	--	7	--	9	5	136
Venezuela	--	(1)	25	--	3	(1)	10	33	10	2	6	111	3	39	242
Others	--	--	2	(1)	(1)	--	--	77	1	--	3	(1)	6	14	103
Total	--	2	189	(1)	4	(1)	91	2,358	15	5	63	547	485	246	4,005
Europe:															
Belgium	--	--	11	--	--	2	(1)	750	2	1	3	3,801	9	12	4,591
Denmark	--	--	1	--	--	--	--	9	2	1	3	123	1	1	141
F ance	--	1	18	(1)	(1)	(1)	(1)	138	2	--	28	735	501	6	1,429
Greece	--	--	(1)	--	--	2	--	10	1	(1)	(1)	164	1	1	179
Ireland	--	(1)	(1)	--	--	--	--	8	(1)	--	2	--	(1)	(1)	10
Italy	--	(1)	7	--	(1)	--	1	356	1	--	25	2,193	697	47	3,327
Netherlands	--	(1)	204	--	--	--	7	567	(1)	1	13	4,680	632	41	6,145
Norway	--	(1)	1	--	--	--	--	21	2	(1)	(1)	1,160	1	3	1,188
Spain	--	(1)	1	--	--	--	--	38	(1)	--	12	1,018	305	21	1,395
Sweden	--	(1)	1	--	--	--	--	99	(1)	--	4	417	63	6	590

United Kingdom	--	1	35	--	--	(1)	1	788	3	2	20	511	929	27	2,317
West Germany	--	(1)	27	--	--	(1)	(1)	252	1	1	277	4,287	26	18	4,889
Yugoslavia	--	--	(1)	--	--	--	--	3	--	1	--	189	(1)	(1)	193
Others	--	53	12	--	1	(1)	1	73	(1)	(1)	3	1	11	6	161
Total	--	55	318	(1)	1	4	10	3,112	14	7	390	19,279	3,176	189	26,555
Middle East:															
Bahrain	--	(1)	(1)	--	--	--	--	3	(1)	2	(1)	299	(1)	1	305
Iran	--	2	(1)	--	--	--	--	126	2	(1)	(1)	109	2	14	255
Israel	--	(1)	1	--	--	--	1	26	(1)	(1)	1	--	11	4	44
Saudi Arabia	--	(1)	2	--	(1)	--	1	176	2	--	1	--	13	6	201
Turkey	--	(1)	1	--	--	--	--	82	1	--	(1)	--	116	17	217
Others	--	(1)	4	--	--	--	1	56	24	(1)	1	31	6	1	124
Total	--	2	8	--	--	--	3	469	29	2	3	439	148	43	1,146
Africa:															
Egypt	--	--	(1)	--	--	--	--	80	--	--	(1)	--	(1)	(1)	80
Ghana	--	--	1	--	--	--	--	56	1	--	(1)	380	2	3	443
Nigeria	--	--	2	--	--	--	--	49	8	--	3	--	2	11	75
South Africa, Republic of	--	(1)	59	--	1	--	--	193	7	(1)	39	--	464	69	832
Tunisia	--	--	--	--	--	--	--	22	--	--	--	117	--	--	139
Others	--	1	2	--	--	(1)	--	144	16	--	6	(1)	7	17	193
Total	--	1	64	--	1	(1)	--	544	32	(1)	48	497	475	100	1,762
Asia and Oceania:															
Australia	--	2	42	--	5	--	2	239	3	1	15	788	364	59	1,520
French Pacific Islands	--	72	1	--	11	--	--	12	1	1	(1)	--	(1)	--	98
India	--	--	1	--	--	--	--	256	(1)	--	3	8	(1)	1	269
Indonesia	--	(1)	(1)	--	(1)	2	1	129	3	--	1	--	18	4	158
Japan	--	(1)	84	--	4	--	43	1,086	7	1	50	12,344	29	161	13,809
Malaysia	--	--	11	--	--	--	--	69	(1)	--	(1)	67	1	2	150
New Zealand	--	(1)	9	--	(1)	--	(1)	30	(1)	(1)	3	295	5	36	378
Philippines	--	(1)	23	--	(1)	--	--	245	4	--	7	(1)	13	29	321
South Vietnam	--	--	--	--	--	--	--	(1)	--	--	--	--	(1)	--	(1)
Taiwan	--	--	1	(1)	--	--	1	103	3	(1)	7	106	3	32	256
Thailand	--	--	5	--	--	--	--	113	2	1	3	--	4	8	136
U.S. Pacific Islands [2]	--	69	(1)	311	--	368	--	14	3	--	(1)	--	--	--	765
Others	--	(1)	27	--	1	(1)	1	333	12	--	14	251	7	31	677
Total	--	143	204	311	21	370	48	2,629	38	4	103	13,859	444	363	18,537
Total exports	1,074	1,013	1,300	969	36	855	4,969	11,936	410	9,038	879	41,244	5,561	1,207	80,491

See footnotes at end of table.

Table 59.—Crude oil and petroleum products exported from the United States, by country of destination—Continued

(Thousand barrels)

	Crude oil	Gasoline	Special naphthas	Jet fuel	Kerosine	Distillate oil	Residual oil	Lubricating oil	Asphalt	Liquefied petroleum gases	Wax	Coke	Petrochemical feedstocks	Miscellaneous products	Total
1975 p															
North America:															
Canada	19	12	274	133	8	6	948	1,224	77	42	65	4,588	464	298	8,158
Mexico	--	49	107	187	1	35	4,001	431	113	9,188	138	1,072	43	60	15,425
Total	19	61	381	320	9	41	4,949	1,655	190	9,230	203	5,660	507	358	23,583
Central America and Caribbean:															
Bahamas	--	5	4	--	(1)	2	20	32	1	1	(1)	--	1	(1)	66
British West Indies	--	--	(1)	--	--	(1)	--	2	4	--	--	--	(1)	(1)	6
Jamaica	--	--	8	--	(1)	(1)	--	182	1	(1)	1	1	2	4	199
Netherlands Antilles	--	--	4	--	--	--	--	18	(1)	--	1	--	(1)	1	24
Panama	--	--	1	--	(1)	--	1	33	1	--	3	--	2	2	43
Puerto Rico	--	434	58	--	--	2	194	272	3	6	18	301	601	41	1,930
Trinidad	--	--	(1)	--	--	--	--	34	1	--	(1)	--	4	3	42
Virgin Islands	2,127	170	2	--	26	8	155	33	1	59	--	--	--	--	2,581
Others	--	(1)	30	--	--	1	5	228	3	6	49	--	14	14	350
Total	2,127	609	107	--	26	13	375	834	15	72	72	302	624	65	5,241
South America:															
Argentina	--	--	16	4	(1)	--	1	260	(1)	--	5	134	1	1	422
Brazil	--	--	61	--	1	--	7	1,264	5	--	3	356	403	127	2,227
Chile	--	--	1	--	--	--	1	120	1	--	5	--	1	7	136
Ecuador	--	--	3	--	--	--	--	22	1	--	11	1	4	5	47
Peru	--	--	1	--	--	--	2	84	(1)	3	5	--	1	8	104
Venezuela	--	(1)	25	--	(1)	--	(1)	32	29	1	17	140	5	40	289
Others	--	(1)	2	--	--	--	(1)	138	(1)	1	4	(1)	6	10	161
Total	--	--	109	4	1	--	11	1,920	36	5	50	631	421	198	3,386
Europe:															
Belgium	--	--	40	--	--	--	--	516	2	--	2	2,615	8	24	3,207
Denmark	--	--	(1)	--	--	1	--	8	(1)	(1)	3	1	1	1	15
France	--	(1)	13	--	--	(1)	(1)	93	(1)	--	14	650	1,241	1	2,012
Greece	--	2	1	--	--	--	--	13	--	--	1	172	1	(1)	190
Ireland	--	--	(1)	--	--	--	--	7	--	--	1	(1)	--	(1)	8
Italy	--	10	21	--	(1)	--	1	206	2	(1)	6	2,724	774	4	3,748
Netherlands	--	(1)	200	--	--	44	(1)	244	(1)	(1)	14	7,073	767	25	8,367
Norway	--	(1)	--	--	--	--	--	11	6	(1)	(1)	1,108	--	1	1,126
Spain	--	--	(1)	--	--	--	(1)	33	(1)	(1)	6	719	577	12	1,347
Sweden	--	--	(1)	--	--	--	(1)	103	1	1	4	281	189	5	584

United Kingdom	--	19	80	--	--	--	(1)	472	3	--	5	486	1,565	6	2,636
West Germany	--	--	2	--	--	(1)	1	205	2	(1)	117	2,933	146	13	3,419
Yugoslavia	--	--	(1)	--	--	--	(1)	4	--	(1)	--	318	--	--	322
Others	--	(1)	3	--	--	--	(1)	43	1	(1)	2	437	8	7	501
Total	--	31	360	--	--	45	2	1,958	17	1	175	19,517	5,277	99	27,482
Middle East:															
Bahrain	--	(1)	(1)	--	(1)	--	--	4	(1)	--	(1)	166	--	1	171
Iran	--	--	1	(1)	--	(1)	--	59	1	--	(1)	107	1	2	171
Israel	--	--	1	--	--	--	1	21	(1)	2	1	(1)	3	1	30
Saudi Arabia	--	--	1	--	--	4	1	191	2	--	(1)	--	4	2	205
Turkey	--	--	--	--	--	--	--	46	(1)	--	(1)	52	105	16	219
Others	--	(1)	18	1	(1)	--	2	91	35	1	12	1	13	25	199
Total	--	--	21	1	--	4	4	412	38	3	13	326	126	47	995
Africa:															
Egypt	--	(1)	(1)	--	--	--	--	121	(1)	--	(1)	--	39	(1)	160
Ghana	--	--	1	--	--	--	--	59	(1)	--	(1)	385	1	(1)	446
Nigeria	--	--	1	--	--	--	--	56	1	(1)	5	--	2	17	82
South Africa, Republic of	--	--	9	--	(1)	--	--	160	3	2	37	64	562	48	885
Tunisia	--	--	--	--	--	--	--	(1)	--	--	--	--	(1)	--	--
Others	--	--	16	--	(1)	--	(1)	134	4	166	9	239	11	27	606
Total	--	--	27	--	--	--	--	530	8	168	51	688	615	92	2,179
Asia and Oceania:															
Australia	--	(1)	66	--	4	--	1	133	10	6	9	378	223	55	885
French Pacific Islands	--	73	--	--	9	--	--	6	--	--	--	--	--	(1)	88
India	--	--	(1)	--	--	--	(1)	346	(1)	(1)	5	--	(1)	3	354
Indonesia	--	(1)	1	--	--	--	--	117	1	2	1	--	9	3	134
Japan	--	4	76	--	(1)	1	(1)	537	3	1	18	9,225	26	121	10,012
Malaysia	--	--	20	--	--	--	--	46	(1)	--	(1)	--	(1)	(1)	66
New Zealand	--	(1)	12	--	--	--	(1)	29	--	--	1	240	3	39	324
Philippines	--	(1)	31	--	--	--	(1)	133	1	--	6	--	200	25	396
South Vietnam	--	--	--	--	--	--	--	(1)	--	--	--	--	(1)	(1)	--
Taiwan	--	--	8	--	--	--	(1)	105	(1)	--	2	--	3	19	137
Thailand	--	(1)	2	--	--	--	--	44	--	--	1	35	3	--	85
U.S. Pacific Islands [2]	--	72	(1)	285	2	163	--	11	1	--	(1)	--	(1)	--	534
Others	--	--	(1)	--	1	--	--	295	--	--	--	251	(1)	(1)	547
Total	--	149	216	285	16	164	1	1,802	16	9	43	10,129	467	265	13,562
Total exports	2,146	850	1,221	610	52	267	5,342	9,111	320	9,488	607	37,253	8,037	1,124	76,428

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[1] Less than ½ unit.
[2] Data reported by shippers to the Bureau of Mines.

Table 60.—Crude, refined products, plant condensate, and unfinished oils imported into the United States, by month [1]

(Thousand barrels)

Year and class	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1974													
Crude petroleum	73,839	62,940	76,329	98,011	121,139	117,747	126,835	121,634	113,907	118,096	118,739	119,939	1,269,155
Petroleum products:													
Motor gasoline	5,047	5,163	6,960	7,790	7,754	6,324	6,562	7,849	6,056	5,303	5,224	4,370	74,402
Jet fuel:													
Naphtha-type	145	26	292	529	1,417	816	1,206	1,553	1,449	802	987	784	10,006
Kerosine-type	4,065	2,073	4,009	3,436	4,946	3,413	5,435	4,839	5,053	4,180	3,206	4,735	49,390
Total jet fuel	4,210	2,099	4,301	3,965	6,363	4,229	6,641	6,392	6,502	4,982	4,193	5,519	59,396
Liquefied gases:													
Butane	2,552	2,102	1,705	1,715	1,395	2,544	2,013	1,637	1,500	1,628	1,980	2,736	23,507
Propane	3,829	2,688	2,011	1,674	2,238	1,050	624	930	796	1,753	1,538	2,333	21,464
Total liquefied gases	6,381	4,790	3,716	3,389	3,633	3,594	2,637	2,567	2,296	3,381	3,518	5,069	44,971
Kerosine	182	365	232	158	--	130	41	153	21	85	218	159	1,744
Distillate fuel oil	14,377	8,577	8,893	6,612	8,305	6,589	6,838	3,369	4,571	7,361	13,629	15,958	105,579
Residual fuel oil	53,727	53,313	53,118	47,785	42,232	44,989	45,691	47,117	42,644	45,426	52,580	50,535	579,157
Petrochemical feedstocks	701	481	323	362	196	83	255	167	443	421	571	361	4,364
Special naphthas	5	162	151	256	277	--	1	1	1	82	1	1	938
Lubricants	210	171	215	118	108	239	139	137	150	153	90	56	1,786
Wax	99	73	90	75	101	85	86	114	46	59	62	66	956
Asphalt	1,028	1,167	859	1,375	2,622	769	650	654	641	736	419	332	11,252
Miscellaneous	--	--	--	--	--	--	24	256	127	220	13	15	655
Plant condensate	3,054	3,433	3,238	3,050	2,000	2,387	2,427	2,488	2,693	2,825	2,718	2,051	32,364
Unfinished oils	3,632	3,315	5,063	6,443	6,564	3,634	3,805	3,799	1,456	2,300	1,977	2,240	44,228
Total petroleum products	92,653	83,109	87,159	81,378	80,155	73,052	75,797	75,563	67,647	73,334	85,213	86,732	961,792
Total crude and products	166,492	146,049	163,488	179,389	201,294	190,799	202,632	197,197	181,554	191,430	203,952	206,671	2,230,947
1975 p													
Crude petroleum	124,901	107,194	113,345	101,338	108,072	117,142	129,966	142,016	140,675	136,068	138,703	138,761	1,498,181
Petroleum products:													
Motor gasoline	8,115	4,784	4,645	3,989	4,398	5,304	6,475	7,184	8,077	6,417	4,180	3,681	67,249
Jet fuel:													
Naphtha-type	730	984	947	413	713	650	490	861	1,420	818	998	1,315	10,339
Kerosine-type	6,381	4,604	3,073	3,709	3,424	2,523	2,230	3,240	2,782	2,473	1,669	2,076	38,184
Total jet fuel	7,111	5,588	4,020	4,122	4,137	3,173	2,720	4,101	4,202	3,291	2,667	3,391	48,523
Liquefied gases:													
Butane	2,052	1,281	1,542	1,884	535	1,472	1,214	1,218	1,582	1,807	2,015	2,067	18,669
Propane	3,486	1,956	1,420	1,169	644	1,304	1,828	1,315	2,040	2,501	1,885	2,510	22,058
Total liquefied gases	5,538	3,237	2,962	3,053	1,179	2,776	3,042	2,533	3,622	4,308	3,900	4,577	40,727

Kerosine	299	234	107	--	42	--	--	80	15	98	141	57	1,073
Distillate fuel oil	10,041	8,453	7,943	3,297	4,225	2,039	3,295	2,854	3,872	3,179	2,894	3,856	55,948
Residual fuel oil	51,043	39,269	40,051	31,400	34,801	27,128	35,470	30,428	39,356	37,837	35,066	34,070	435,919
Petrochemical feedstocks	974	--	93	--	100	336	--	380	--	--	--	178	2,061
Special naphthas	--	30	1	1	1	--	2	1	2	2	1	2	43
Lubricants	90	184	137	150	1	71	137	81	67	202	106	109	1,335
Wax	55	78	58	114	4	33	57	8	62	87	64	64	684
Asphalt	253	303	217	233	522	672	539	787	471	418	302	239	4,956
Miscellaneous	264	418	186	246	320	36	43	--	266	235	43	283	2,340
Plant condensate	2,430	1,836	2,544	2,231	1,828	2,212	2,311	2,514	2,646	1,842	1,971	2,607	26,972
Unfinished oils	921	1,323	1,330	817	841	1,291	1,354	1,066	816	1,212	836	1,178	12,985
Total petroleum products	87,134	65,737	64,294	49,653	52,399	45,071	55,445	52,017	63,474	59,128	52,171	54,292	700,815
Total crude and products	212,035	172,931	177,639	150,991	160,471	162,213	185,411	194,033	204,149	195,196	190,874	193,053	2,198,996

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[1] Imports for onshore of military jet fuel, distillate and residual fuel oils, and receipts from Puerto Rico, the Virgin Islands, and Guam included in these data are based on figures reported to the U.S. Department of the Interior. All other import figures are compiled from U.S. Department of Commerce data.

Table 61.—Crude oil and petroleum products imported into the United States, by country and receiving district

(Thousand barrels)

Country and PAD district	Gasoline	Jet fuel		Kerosine	Liquefied gases	Distillate fuel oil	Residual fuel oil	Petrochemical feedstocks	Special naphthas	Lubricants	Wax	Asphalt	Unfinished oils	Plant condensate	Miscellaneous oils	Crude oils	Total
		Naphtha-type	Kerosine-type														
1974																	
North America:																	
Canada	1,581	5	2,663	15	30,384	2,500	28,238	--	907	49	84	504	2,836	31,840	--	288,763	390,369
Mexico	--	--	--	--	--	316	898	--	--	--	20	2	1,261	--	--	597	3,094
Total	1,581	5	2,663	15	30,384	2,816	29,136	--	907	49	104	506	4,097	31,840	--	289,360	393,463
Central America and Caribbean:																	
Bahamas	--	--	3,794	--	--	7,372	40,028	51	--	--	--	--	8,330	--	198	--	59,773
British West Indies	197	--	--	--	--	250	1,055	--	--	--	--	--	--	--	--	--	1,502
Guatemala	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Netherlands Antilles	5,888	960	16,522	--	575	16,698	133,005	815	--	--	--	8,912	3,132	--	--	--	186,507
Panama	336	28	502	--	--	393	--	--	--	--	--	2	--	--	--	--	1,261
Puerto Rico	16,424	--	218	21	--	9,225	1,823	284	--	1,479	607	--	2,811	--	115	--	33,007
Virgin Islands	16,415	4,052	--	700	--	16,680	103,122	843	--	--	--	--	893	--	--	--	142,705
Total	39,261	5,040	21,036	721	575	50,618	279,033	1,993	--	1,479	607	8,914	15,166	--	313	--	424,756
South America:																	
Bolivia	--	--	20	--	--	--	--	--	--	--	--	--	--	--	--	2,467	2,487
Brazil	--	--	--	--	--	--	745	--	--	--	--	--	--	--	--	--	745
Colombia	163	--	--	--	--	344	1,222	--	--	34	25	--	--	--	--	--	1,788
Ecuador	--	--	--	--	--	--	155	--	--	--	--	--	--	--	--	15,225	15,380
Peru	--	--	--	--	--	--	1,587	--	--	--	--	--	--	--	--	--	1,587
Trinidad	5,960	2,978	5,408	41	--	8,464	43,916	1,231	--	65	6	9	62	--	342	23,045	91,527
Venezuela	3,955	838	7,782	--	11,634	16,559	180,797	383	--	--	--	1,822	16,639	524	--	116,437	357,370
Total	10,078	3,816	13,210	41	11,634	25,367	228,422	1,614	--	99	31	1,831	16,701	524	342	157,174	470,884
Europe:																	
Belgium	858	--	29	--	--	1,034	795	--	--	57	--	--	--	--	--	--	2,773
Finland	1,532	--	--	--	--	132	--	--	--	--	--	--	--	--	--	--	1,664
France	913	--	--	--	--	216	538	--	--	7	--	--	346	--	--	--	2,020
Greece	322	--	140	--	--	--	280	335	--	58	--	--	566	--	--	--	1,701
Italy	5,949	7	1,325	157	--	6,551	12,086	--	--	--	--	--	1,016	--	--	--	27,091
Netherlands	5,184	--	470	53	276	7,089	2,280	--	--	7	32	--	277	--	--	--	15,668
Norway	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	322	322
Portugal	--	--	--	--	--	--	216	--	--	--	--	--	--	--	--	--	216
Romania	1,975	--	--	--	--	462	1,235	--	--	--	--	--	621	--	--	--	4,293
Spain	789	--	215	--	--	1,274	881	--	--	--	--	1	1,077	--	--	--	4,237
Switzerland	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
Turkey	1,009	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,009
U.S.S.R.	988	--	--	757	--	3,496	1,152	422	--	--	2	--	301	--	--	--	7,118
United Kingdom	43	--	--	--	84	1,246	1,341	--	--	3	8	--	42	--	--	--	2,767
West Germany	154	--	--	--	--	1,989	726	--	--	--	18	--	--	--	--	--	2,887
Total	19,716	7	2,179	967	360	23,489	21,530	757	--	133	60	1	4,246	--	--	322	73,767

Middle East:																	
Bahrain	1,484	291	1,748	--	--	1,012	6	--	--	--	--	--	--	--	--	--	4,541
Iran	171	13	1,270	--	13	107	226	--	--	--	--	--	365	--	--	168,956	171,121
Israel	--	--	--	--	--	--	9	--	--	--	--	--	--	--	--	--	9
Kuwait	--	--	--	--	--	155	--	--	--	--	--	--	--	--	--	1,820	1,975
Oman	--	--	25	--	16	--	--	--	--	--	--	--	--	--	--	236	277
Qatar	159	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,189	6,348
Saudi Arabia	353	297	754	--	1,836	761	2,572	--	--	--	--	--	1,958	--	--	159,827	168,358
United Arab Emirates	--	--	--	--	--	1	1,593	--	--	--	--	--	220	--	--	25,158	26,972
Yemen	--	--	252	--	1	--	--	--	--	--	--	--	--	--	--	--	253
Total	2,167	601	4,049	--	1,866	2,036	4,406	--	--	--	--	--	2,543	--	--	362,186	379,854
Asia:																	
Brunei	--	--	14	--	--	--	--	--	--	--	--	--	--	--	--	--	14
India	--	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	5
Indonesia	--	57	55	--	32	295	4,871	--	--	--	69	--	769	--	--	103,482	109,630
Japan	42	--	374	--	--	5	--	--	--	26	29	--	--	--	--	--	476
Korea	--	--	148	--	--	--	--	--	--	--	--	--	--	--	--	--	148
Malaysia	--	99	3,233	--	24	185	323	--	--	--	--	--	--	--	--	510	4,374
Philippines	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	2
Singapore	--	--	2,358	--	35	--	--	--	--	--	14	--	152	--	--	--	2,559
Taiwan	--	--	--	--	--	--	--	--	--	--	--	--	30	--	--	--	30
Total	42	156	6,182	--	91	485	5,196	--	--	26	117	--	951	--	--	103,992	117,238
Africa:																	
Algeria	141	--	35	--	--	210	3,098	--	--	--	--	--	144	--	--	65,764	69,392
Angola	--	--	--	--	--	--	453	--	--	--	--	--	--	--	--	17,536	17,989
Congo (Brazzaville)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	670	670
Egypt	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	3,227	3,234
Gabon	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8,552	8,552
Ghana	--	--	--	--	--	142	1,529	--	--	--	--	--	--	--	--	--	1,671
Libya	--	--	--	--	--	--	113	--	--	--	--	--	--	--	--	1,495	1,608
Nigeria	--	--	33	--	55	78	5,877	--	--	--	--	--	4	--	--	254,358	260,405
South Africa, Republic of	--	--	--	--	--	--	--	--	--	--	37	--	--	--	--	--	37
Tunisia	--	--	--	--	--	144	--	--	--	--	--	--	--	--	--	4,519	4,663
Total	141	--	68	--	55	574	11,077	--	--	--	37	--	148	--	--	356,121	368,221
Oceania:																	
Australia	--	--	--	--	--	--	265	--	--	--	--	--	--	--	--	--	265
Guam	--	128	--	--	--	--	--	--	--	--	--	--	--	--	--	--	128
Hawaii Foreign Trade Zone	1,416	253	3	--	6	194	92	--	31	--	--	--	376	--	--	--	2,371
Total	1,416	381	3	--	6	194	357	--	31	--	--	--	376	--	--	--	2,764
Total imports	74,402	10,006	49,890	1,744	44,971	105,579	579,157	4,364	938	1,786	956	11,252	44,228	32,364	655	1,269,155	2,230,947
Imports by PAD district:																	
District I	64,176	6,769	27,789	1,453	5,958	95,018	538,573	941	2	1,547	847	10,785	14,084	2,903	655	428,608	1,200,108
District II	451	--	1,575	--	19,304	621	7,919	--	905	32	3	38	1,155	19,012	--	250,771	301,786
District III	6,851	861	2,987	291	9,566	6,766	11,806	3,423	--	173	88	418	19,208	126	--	289,999	352,563
District IV	322	--	--	--	5,535	32	--	--	--	4	--	--	--	8,250	--	16,579	30,722
District V	2,602	2,376	17,039	--	4,608	3,142	20,859	--	31	30	18	11	9,781	2,073	--	283,198	345,768

See footnote at end of table.

Table 61.—Crude oil and petroleum products imported into the United States, by country and receiving district—Continued

(Thousand barrels)

Country and PAD district	Gasoline	Jet fuel		Kerosine	Liquefied gases	Distillate fuel oil	Residual fuel oil	Petrochemical feedstocks	Special naphthas	Lubricants	Wax	Asphalt	Unfinished oils	Plant condensate	Miscellaneous oils	Crude oil	Total
		Naphtha-type	Kerosine-type														
1975 p																	
North America:																	
Bermuda	--	--	--	--	--	--	129	--	--	--	--	--	--	--	--	--	129
Canada	3,953	--	2,311	40	30,295	1,644	23,084	--	43	8	69	243	660	26,972	--	219,175	308,497
Mexico	--	--	--	--	--	131	132	--	--	--	6	--	--	--	--	25,660	25,929
Total	3,953	--	2,311	40	30,295	1,775	23,345	--	43	8	75	243	660	26,972	--	244,835	334,555
Central America and Caribbean:																	
Bahamas	--	--	5,987	--	--	940	45,302	773	--	--	--	--	2,343	--	150	--	55,495
British West Indies	110	--	--	--	--	--	221	--	--	--	--	--	--	--	--	--	331
Honduras	--	--	--	--	--	--	108	--	--	--	--	--	--	--	--	--	108
Netherlands Antilles	3,183	112	7,870	--	27	4,298	96,295	588	--	1	--	4,465	1,046	--	237	--	118,122
Panama	621	--	1,479	--	--	404	2,181	100	--	--	--	--	209	--	--	--	4,994
Puerto Rico	16,617	--	--	90	--	8,231	2,549	--	--	1,211	526	--	3,143	--	382	--	32,749
Virgin Islands	25,386	8,371	--	938	--	18,933	94,715	--	--	--	--	--	--	--	--	--	148,343
Total	45,917	8,483	15,336	1,028	27	32,806	241,371	1,461	--	1,212	526	4,465	6,741	--	769	--	360,142
South America:																	
Bolivia	--	--	43	--	--	--	--	--	--	--	--	--	--	--	--	1,940	1,983
Brazil	417	--	208	--	--	148	1,171	--	--	--	--	--	--	--	--	--	1,944
Chile	173	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	173
Colombia	--	--	--	--	--	--	3,261	--	--	--	9	--	--	--	--	--	3,270
Ecuador	--	--	--	--	--	--	103	--	--	--	--	--	--	--	--	20,679	20,782
Peru	--	--	--	--	--	--	1,385	--	--	--	--	--	--	--	--	--	1,385
Trinidad	3,758	742	5,170	--	--	5,897	28,304	451	--	22	--	3	303	--	1,187	42,097	87,934
Venezuela	1,843	--	5,185	5	4,965	6,513	88,288	--	--	1	--	234	3,152	--	213	144,221	254,620
Total	6,191	742	10,606	5	4,965	12,558	122,512	451	--	23	9	237	3,455	--	1,400	208,937	372,091
Europe:																	
Austria	--	--	--	--	--	--	42	--	--	--	--	--	--	--	--	--	42
Belgium	1,265	--	--	--	4	184	862	--	--	--	--	--	--	--	--	--	2,315
Denmark	--	--	--	--	--	--	128	--	--	--	--	--	--	--	--	--	128
Finland	163	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	163
France	--	--	--	--	142	--	2,045	--	--	6	4	--	--	--	--	--	2,197
Greece	23	--	--	--	--	--	16	--	--	--	--	--	--	--	--	--	39
Italy	1,817	--	718	--	--	1,305	5,380	149	--	--	31	--	--	--	--	--	9,400
Netherlands	668	--	317	--	--	694	3,552	--	--	--	--	11	--	--	--	1,500	6,742
Norway	160	--	--	--	--	--	1,328	--	--	--	--	--	--	--	--	4,552	6,040
Romania	1,390	--	--	--	--	597	3,131	--	--	--	--	--	--	--	--	--	5,118
Spain	--	--	115	--	--	143	--	--	--	--	--	--	--	--	--	--	258
Sweden	233	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	234
Turkey	347	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	347
U.S.S.R	--	--	--	--	--	556	5,236	--	--	--	--	--	--	--	--	--	5,792
United Kingdom	--	--	69	--	4	719	2,948	--	--	--	1	--	--	--	--	125	3,866
West Germany	--	--	4	--	--	264	405	--	--	85	9	--	--	--	--	--	767
Yugoslavia	--	--	--	--	--	--	--	--	--	--	--	--	15	--	--	--	15
Total	6,066	--	1,223	--	150	4,462	25,073	149	--	92	45	11	15	--	--	6,177	43,463

Middle East:																	
Bahrain	2,130	50	2,436	--	--	1,019	139	--	--	--	--	--	--	--	--	--	5,774
Iran	150	--	266	--	88	--	225	--	--	--	--	--	32	--	--	101,575	102,336
Iraq	194	--	--	--	--	--	--	--	--	--	--	--	--	--	--	707	901
Kuwait	--	--	57	--	946	2,916	264	--	--	--	--	--	--	--	--	1,444	5,627
Oman	85	--	--	--	31	--	--	--	--	--	--	--	--	--	--	492	608
Qatar	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,657	6,657
Saudi Arabia	90	--	175	--	3,028	162	--	--	--	--	--	--	1,490	--	--	256,036	260,981
United Arab Republic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	42,585	42,585
Yemen	--	--	181	--	--	--	--	--	--	--	--	--	--	--	--	--	181
Total	2,649	50	3,115	--	4,093	4,097	628	--	--	--	--	--	1,522	--	--	409,496	425,650
Asia:																	
Brunei	280	--	25	--	23	--	--	--	--	--	--	--	--	--	--	--	328
Gaza Strip	--	--	--	--	26	--	--	--	--	--	--	--	--	--	--	--	26
India	--	--	--	--	--	--	--	--	--	--	--	--	179	--	--	--	179
Indonesia	206	--	137	--	62	--	3,103	--	--	--	--	--	--	--	--	138,270	141,778
Japan	--	--	5	--	--	--	273	--	--	--	15	--	7	--	--	--	300
Korea	--	--	79	--	--	--	--	--	--	--	--	--	--	--	--	--	79
Malaysia	--	--	718	--	--	111	--	--	--	--	--	--	246	--	--	1,951	3,026
Singapore	141	--	4,324	--	40	--	483	--	--	--	--	--	--	--	--	--	4,988
Taiwan	--	195	--	--	--	--	--	--	--	--	--	--	--	--	--	--	195
Total	627	195	5,288	--	151	111	3,859	--	--	--	15	--	432	--	--	140,221	150,899
Africa:																	
Algeria	146	--	8	--	891	--	4,923	--	--	--	--	--	160	--	171	96,459	102,758
Angola	1	--	--	--	5	--	1,099	--	--	--	--	--	--	--	--	26,051	27,156
Congo (Brazzaville)	--	--	--	--	--	--	1,166	--	--	--	--	--	--	--	--	--	1,166
Egypt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,687	1,687
Gabon	--	--	--	--	--	--	212	--	--	--	--	--	--	--	--	9,811	10,023
Ghana	--	--	--	--	--	--	1,205	--	--	--	--	--	--	--	--	--	1,205
Libya	202	--	--	--	--	--	3,070	--	--	--	--	--	--	--	--	81,403	84,675
Nigeria	--	--	--	--	71	48	5,574	--	--	--	--	--	--	--	--	272,265	277,958
South Africa, Republic of	--	--	--	--	--	--	--	--	--	--	14	--	--	--	--	--	14
Tunisia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	839	839
Total	349	--	8	--	967	48	17,249	--	--	--	14	--	160	--	171	488,515	507,481
Oceania:																	
Australia	--	--	146	--	--	--	1,682	--	--	--	--	--	--	--	--	--	1,828
Guam	--	161	--	--	--	--	--	--	--	--	--	--	--	--	--	--	161
Hawaii Foreign Trade Zone	1,497	708	151	--	79	91	200	--	--	--	--	--	--	--	--	--	2,726
Total	1,497	869	297	--	79	91	1,882	--	--	--	--	--	--	--	--	--	4,715
Total imports	67,249	10,339	38,184	1,073	40,727	55,948	435,919	2,061	43	1,335	684	4,956	12,985	26,972	2,340	1,498,181	2,198,996
Imports by PAD district:																	
District I	59,917	8,721	19,377	1,073	6,716	53,759	407,207	378	--	1,265	668	4,920	6,038	2,959	2,340	451,549	1,026,887
District II	1,285	--	769	--	17,894	196	13,771	--	43	9	2	4	392	15,101	--	282,658	322,124
District III	1,554	112	1,752	--	5,386	1,441	3,957	1,683	--	59	14	31	4,170	--	--	437,049	457,208
District IV	22	--	4	--	5,706	1	--	--	--	--	--	--	--	6,594	--	16,090	28,417
District V	4,471	1,506	16,282	--	5,025	551	10,984	--	--	2	--	1	2,885	2,818	--	810,835	854,360

Source: Imports of crude oil, unfinished oils, and plant condensate are reported to the Bureau of Mines. All other import data are compiled from U.S. Department of Commerce and Federal Energy Administration data.

Table 62.—Crude petroleum: World production by country

(Thousand 42-gallon barrels)

Country	1973	1974	1975 p
North America:			
Barbados	10	48	123
Canada	648,348	616,532	520,666
Cuba e	775	775	775
Mexico 1	191,482	238,271	294,254
Trinidad and Tobago	60,666	68,131	78,613
United States 1	3,360,903	3,202,585	3,052,048
South America:			
Argentina	153,539	151,110	144,364
Bolivia	17,266	16,603	14,732
Brazil	62,122	64,751	62,766
Chile	11,429	10,055	8,946
Colombia	66,844	60,867	57,259
Ecuador	76,221	63,678	58,753
Peru	25,767	28,069	26,384
Venezuela	1,228,594	1,086,332	856,364
Europe:			
Albania	14,058	15,045	15,012
Austria	17,982	15,609	14,205
Bulgaria	1,460	1,095	913
Czechoslovakia	1,221	1,085	1,017
Denmark	1,460	689	1,327
France	9,152	7,863	7,460
Germany, East	2,500	2,500	e 2,500
Germany, West	47,944	44,718	41,470
Hungary	15,176	15,237	15,306
Italy	7,082	6,956	6,743
Netherlands	10,169	10,227	9,676
Norway	11,166	12,707	68,900
Poland	2,908	4,080	4,103
Romania	106,578	107,964	108,739
Spain	5,932	14,334	14,822
U.S.S.R.1	3,094,350	3,373,650	3,608,850
United Kingdom 1	2,946	3,289	8,000
Yugoslavia	24,680	25,613	27,347
Africa:			
Algeria	400,515	368,139	350,753
Angola	58,910	61,392	57,943
Congo (Brazzaville)	12,713	22,434	13,460
Egypt	60,483	53,715	84,348
Gabon	55,045	73,548	81,948
Libya	793,839	555,291	551,150
Morocco	320	191	171
Nigeria	749,820	823,347	651,890
Tunisia	29,828	31,841	34,567
Zaire	--	--	25
Asia:			
Bahrain	24,948	24,597	20,805
Brunei	78,673	70,338	65,932
Burma	7,514	7,581	6,700
China, People's Republic of e	365,000	474,500	571,590
India	55,388	55,733	61,611
Indonesia	488,536	501,838	477,055
Iran	2,139,229	2,197,901	1,952,650
Iraq	736,607	720,729	825,521
Israel e 2	32,193	36,500	27,345
Japan	5,142	4,936	4,378
Kuwait 3	1,102,446	929,678	761,438
Malaysia (Sarawak)	33,054	29,537	35,774
Oman	106,926	106,046	124,600
Pakistan	2,871	2,923	2,190
Qatar	208,152	189,348	159,482
Saudi Arabia 3	2,772,590	3,095,640	2,582,354
Syrian Arab Republic	38,170	45,352	65,930
Taiwan	1,055	1,321	1,351
Thailand	45	e 42	e 42
Turkey	24,273	24,555	22,167
United Arab Emirates:			
Abu Dhabi	479,192	516,110	511,730
Dubai	80,207	100,375	92,710
Sharjah	--	--	13,870
Oceania:			
Australia	142,277	140,396	149,873
New Zealand 1	1,290	1,385	1,423
Total	20,367,981	20,537,727	19,497,213

e Estimate. p Preliminary.
1 Includes field condensate.
2 Estimates of Israeli production from Sinai peninsula oilfields included with Israel rather than with Egypt.
3 Data for both Kuwait and Saudi Arabia include those countries share of production from the Kuwait-Saudi Arabia Partitioned Zone.

Phosphate Rock

By W. F. Stowasser [1]

In the United States, the average unit value of phosphate rock increased from $10.98 per ton, f.o.b. plant, in 1974 to $22.99 per ton, f.o.b. plant, in 1975. Although the published price of phosphate rock in international trade did not change during 1975, consumer resistance to higher price levels caused significant reduction in listed prices effective January 1, 1976, and negotiations between sellers and buyers established agreeable prices at less than published prices.

Additional marketing complications were created for both producers and consumers of phosphate rock as resistance to high prices for phosphate fertilizers backed up supplies in delivery pipelines in the United States and other major consuming and producing areas. As phosphate fertilizer prices declined in the United States, and with the domestic market not responding to the decline in prices, it was advantageous for U.S. integrated fertilizer producers to increase the level of shipments of relatively cheap fertilizers into world markets. It was equally advantageous for consuming countries to import fertilizer from the United States which was more than competitive with fertilizer produced in respective domestic plants utilizing exceptionally high-cost imported phosphate rock. This condition added pressure on major phosphate rock producers in North Africa and the United States to reduce the price of phosphate rock in international trade.

Estimated world production in 1975 was about 118.6 million short tons, about 3% below the 1974 record production level. After 4 years of demand exceeding production, demand declined and supplies were more than adequate in 1975. The sharpest decline in demand for phosphate occurred in West Europe where imports declined almost 7 million tons. The deterioration in export prices started in October 1975 when Morocco discounted published prices in an attempt to increase sales, which had markedly declined in 1975 from the record high in 1974.

In October, Morocco, which has a common boundary with the Spanish Sahara and had claimed the territory since 1956, mounted a march of an estimated 350,000 Moroccans into the Spanish territory with the declared objective of peacefully recovering the area. A Spanish minefield, about 10 miles south of the border, deterred further penetration into the territory and the march was terminated. Spain agreed to cede the territory to Morocco and Mauritania. In return, Spain will receive an as yet unspecified share in the Bu Craa phosphate operation, some continuing military rights at El Auin, and some fishing rights off the coast. The acquisition of the phosphate mine, plant, and reserves in the "Western Sahara" by Morroco will increase control over this commodity by the semi-monopoly of North African phosphate rock producers.

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[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient phosphate rock statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Mine production	125,752	126,651	139,713	155,847	187,516
Marketable production	38,886	40,831	42,137	45,686	48,816
Value	$203,828	$207,910	$238,667	$501,429	$1,122,184
Average per ton	$5.24	$5.09	$5.66	$10.98	$22.99
Sold or used by producers	40,291	43,755	45,043	48,435	46,439
Value	$211,986	$223,005	$254,846	$529,141	$1,052,995
Average per ton	$5.26	$5.10	$5.66	$10.92	$22.67
Exports [1]	12,587	14,275	13,875	r 13,409	11,321
P_2O_5 content	4,126	4,673	4,502	4,468	3,955
Value	$64,841	$75,376	$82,983	r 239,693	424,924
Average per ton	$5.15	$5.28	$5.98	r $17.88	$37.53
Imports for consumption [2]	84	55	65	182	37
Value	$2,478	$1,416	$1,288	$8,999	$1,604
Average per ton	$29.50	$25.75	$19.82	$49.45	$42.65
Consumption, apparent [3]	27,788	29,535	31,233	34,720	34,203
World: Production	96,040	99,287	r 108,823	r 122,147	118,586

r Revised.
[1] From table 3.
[2] Bureau of the Census data.
[3] Measured by sold or used plus imports minus exports.

Legislation and Government Programs.—Applications by companies to mine phosphate rock in the Los Padres National Forest of California, the Caribou National Forest in Idaho, and the Osceola National Forest in northern Florida were not granted in 1975. Thomas S. Kleppe, Secretary of the Interior, deferred a decision on preference right leases in the Osceola National Forest in order to complete a 2-year study of the effects of phosphate mining on the underground water supply. A task force, under the direction of the Geological Survey, continued work on the Environmental Impact Statement on Development of Phosphate Resources in southeastern Idaho. The Environmental Impact Statement to assess the impacts of mining phosphate rock in the Los Padres National Forest was not released during 1975. The State of North Carolina did not issue a mining permit to the North Carolina Phosphate Corp. in 1975. Although several new mines were under construction in central Florida, mining permits were not granted in Manatee, Hardee, and De Soto Counties. Mine construction and permits in Polk and Hillsborough Counties were limited.

The Bureau of Mines was involved in a number of programs relating to Florida phosphates in 1975. A cooperative program was started in 1972 with the Florida phosphate industry to study the disposal and dewatering of phosphate waste slimes and continued through 1975. Several university grants were issued to supplement knowledge about phosphate waste fractions. A grant to the Florida Bureau of Geology was made to define and classify phosphate lands and correlate the data with the Environmental Protection Agency (EPA) and State of Florida radiation data. The Bureau of Mines initiated studies to determine the feasibility of recovering an acceptable grade of phosphate mineral from the Hawthorn Formation.

EPA studied radiation in structures on reclaimed land, studied worker exposure to radiation in mines and chemical plants, analyzed radiation levels in citrus fruit, analyzed radium 226 levels in central Florida well water, and analyzed radium 226 levels in recharge wells.

The phosphate mining industry, particularly in Florida, North Carolina, Idaho, and Tennessee, is subjected to regulation by county, State, and Federal governments. Compliance with all regulations has become expensive and time consuming for the industry and, in a majority of instances in 1975, delayed or deferred new phosphate rock mines. In Florida, permit requirements for major industrial developments that were in effect in 1975 can be summarized. On the Federal level, EPA, under authority of the Federal Water Pollution Control Act of 1972, and in compliance with the National Pollutant Discharge Elimination System (NPDES), requires that a permit be obtained for discharge of industrial waste water. If the source being permitted is a new source, that is, constructed after publication of proposed EPA guidelines, EPA must comply with the National Environmental Policy Act of 1969, which may require preparation of an Environmental Impact Statement. Under Section 404 of the

Federal Water Pollution Control Act, the U.S. Army Corps of Engineers may require approval for construction or mining activities in "wet lands." The Corps may be required to prepare an Environmental Impact Statement and, if also required by the EPA, it would be jointly prepared by both agencies. Prior to construction of a potential source of air pollution, the applicant must obtain approval under EPA's significant deterioration rule, 40 C.F.R., Part 52, which requires a preconstruction review of all proposed new major stationary sources to assure preservation of certain "clean air" areas.

The State of Florida Division of State Planning issued guidelines for determining the need for a "Development of Regional Impact" (DRI) report on any development which, because of its character, magnitude, or location, would have a substantial effect on the health, safety, or welfare of citizens of more than one county. For mining operations, a DRI would be required if the removal or disturbance of solid minerals or overburden over an area, not necessarily contiguous, would exceed 100 acres or whose water consumption would exceed 3 million gallons per day. After the DRI is submitted, the planning council reviews it and issues a report to the county. The planning council recommendation considers if the proposed action will have favorable or unfavorable effects on the natural resources of the region, the economy of the region, the public facilities such as water availability and sewer adequacy of the region, public transportation, and housing facilities. The recommendations are considered by the county governments concerned.

The State of Florida is involved in land reclamation. Guidelines of the Department of Natural Resources, chapter 16C–16 (1975), sets the rules for acceptance of credit for reclaimed land. Before a credit (a rebate of a portion of the severance tax) is granted, the guidelines must be met. The 1975 severance tax rate was 5% of the established value of the mineral at the point of severance with a credit of ad valorem taxes if a reclamation program is ongoing. The reclamation credit may be 50% of the remainder of the taxes if approved by the Department of Natural Resources. Criteria for credit under the 1975 law considers water quality, bank slopes, timing, revegetation, and safety. The Department of Natural Resources also regulates the construction specifications for water wells.

The State Department of Environmental Regulation was established in May 1975. This new Department combines the Department of Pollution Control, elements from the Department of Natural Resources, the Internal Improvement Trust Fund, the Bureau of Sanitary Engineering, and five water management districts. The Department authority covers National Pollution Discharge Elimination System permits; applicable to the phosphate industry were permits for industrial waste waters and air emissions, dam construction, dredge and fill activities, and sewer waste water.

The Florida Water Resource Act of 1972 established drainage districts throughout the State. The largest district is the Southwest Florida Water Management District (SWFMD) with jurisdiction over most of central Florida. SWFMD requires permits for well construction, water withdrawal or discharge, construction across or within, or other use of "works" of the water district, which includes the Peace River, its tributaries, and other river and water bodies. In December 1974, the district adopted rules for granting permits for the "consumptive uses of water." The policy adopted requires extensive hydrologic groundwater testing prior to consideration of permits for new withdrawals by phosphate companies. Issuance of a permit is contingent on volume and water-quality monitoring data, use (where possible) of recharge wells, utilization of surface water, maintenance of streams and rain gage stations, and the potential for "zero net withdrawal."

The Florida Counties of Alachua, De Soto, Hillsborough, Hardee, Manatee, and Polk have enacted mining or earth-mining ordinances to control mining activities. A zoning variance for these activities is granted based on a conceptual mining plan, followed by a permit-granting procedure that involves monitoring and an annual review of the mining methodology, reclamation progress, and compliance with regulations covering dam construction, settling ponds, easements to adjacent owners, soil vibrations, noise, flood plain restrictions, standards for water, air, ground water, rainfall, sewage effluent, and radiation; meeting reclamation standards as to slopes, lake depths, and time limitations; and continued monitoring of ground-water quality and quantity. The application for a zoning variance for a new development requires that a master mining and reclamation plan be prepared and that they include specifics on mining sequences, timing on mine development, specifications on reclamation, and water withdrawal plans. Concurrently, for new developments, an application for approval of a DRI must be filed with the county. The Regional Planning Council with jurisdiction submits a recommendation for denial or approval to the county. The county includes this recommendation in public hearing procedures for zoning variances and the DRI submitted material. If approved by the county, detailed mining plans are prepared by the company and submitted to obtain a mining permit. The county annually reviews and approves the mining permit. If the county does not approve the DRI, a minimum of 6 months must elapse before another application can be submitted.

DOMESTIC PRODUCTION

The total U.S. domestic production of marketable phosphate rock was 48,816,000 tons, an increase of 3,130,000 tons or 6.9% over that of 1974. The value of the marketable rock was $1,122,184,000, an increase of 124% over that of 1974. The average grade of phosphate ore mined in the United States was 12.5% P_2O_5 and the average grade of marketable rock was 30.8% P_2O_5, the same as that in 1974. The average weight recovery of concentrate and rock marketable as mined was 26.0%, down from the 29.3% average weight recovery in 1974. The average P_2O_5 recovery was 64.0%, considerably less than the 67.7% P_2O_5 average recovery in 1974. In the United States, Florida and North Carolina produced 40,669,000 tons (83.4%) of marketable phosphate rock, the Western States produced 5,825,000 tons (11.9%), and Tennessee produced 2,291,000 tons (4.7%).

Florida and North Carolina.—Production of marketable phosphate rock was 40,699,000 tons, an increase of 10.1% over that of 1974. The value of marketable rock was $1,000,352,000, an increase of $591,373,000, or 144.6% over that of 1974.

The average grade of phosphate ore mined was 11.8%, somewhat less than the average of 12.5% P_2O_5 in 1974, and the average grade of marketable rock was 31.3% P_2O_5, essentially the same as the average grade of 31.4% P_2O_5 in 1974.

The average weight recovery of concentrate and rock marketable as mined was 23.4%, down from an average weight recovery of 26% in 1974. The average P_2O_5 recovery was 62.2%, down from an average P_2O_5 recovery of 65.6% in 1974. The decline in weight and P_2O_5 recovery in 1975 can be partly attributed to the startup of new mines that only recovered pebble and stored concentrate feed for treatment in 1976. The increase in production in 1975 in Florida and North Carolina was characterized by moderate increases by a majority of the operating companies; the more significant gains were shown by Agrico Chemical Co., Borden, Inc., and Swift Chemical Co.

Agrico Chemical Co.; Borden, Inc.; Brewster Phosphates; Gardinier, Inc.; W. R. Grace & Co.; International Minerals & Chemical Corp. (IMC); Mobil Oil Corp.; Poseidon Mines, Inc.; Occidental Petroleum Corp.; USS Agri-Chemicals, Inc.; and Swift Chemical Co. produced marketable rock from Florida land-pebble phosphate fields. Howard Phosphate Co., Kellogg Co., Loncala Phosphate Co., and Manko Co. mined 28,000 tons of soft rock in Florida.

In North Carolina, Texasgulf, Inc., continued with plans to increase mining capacity at its Lee Creek mine. Added in late 1975 was an electric hydraulic dredge with a 30-inch cutter head to strip the top 40 feet of overburden and a new 45-cubic-yard dragline. With these additions and changes to the washing and concentration plants, Texasgulf, Inc. will have 5 million tons per year of marketable phosphate rock capacity. North Carolina Phosphate Corp., jointly owned by Agrico Chemical Co. and Kennecott Copper Corp., continued planning and working on a future phosphate rock mine and plant in North Carolina. Water-pumping permits were not issued to North Carolina Phosphate Corp. in 1975. Until the State of North Carolina issues the water permits, the schedule for construction of the proposed mine and plant could not be established in 1975.

In northern Florida, Occidental Chemical Co., a division of Occidental Petroleum Corp., completed the Swift Creek mine in late 1975. The plant is designed to produce 2.5 million tons per year and, together with the existing Suwanee River mine, Occidental will have a capacity in excess of 5 million tons per year.

In central Florida, Agrico Chemical Co. started operating the concentrator at its new Fort Green mine at yearend and plans to close the Palmetto mine in early 1976. The new Fort Lonesome mine of Brewster Phosphates was nearing completion in late 1975. The plant will start up in 1976 and produce at a rate of 2.8 million tons per year. W. R. Grace & Co.'s Hooker's Prairie mine, under construction about 4 miles southeast of Bradley, Fla., will be completed and will start producing at a rate of 2.5 million tons per year in mid-1976. T-A Minerals, Inc., has a washer and concentration plant under construction south of Mulberry, Fla. The plant is expected to start production in the second quarter of 1976.

A number of other companies have published their intentions to construct new plants or study the feasibility of opening new mines in Polk, Hillsborough, Manatee, Hardee, and De Soto Counties. Either the studies were incomplete or the necessary approvals and permits to proceed with mine construction were not obtained.

Western States.—Production of marketable phosphate rock was 5,825,000 tons, a decrease of 470,000 tons or 7.5% less than was produced in 1974. Lower production from mines in Idaho was the principal reason for lower production in the Western States.

The value of the marketable rock increased to $93,029,000, 25.7% higher than the value in 1974. The average grade of mined phosphate ore was 22.5% P_2O_5. The average grade of mined phosphate rock used without beneficiation was 26.6% P_2O_5. The average grade of beneficiated rock was 31.7% P_2O_5. The average grade of all marketable rock was 29.0% P_2O_5. Of the total phosphate rock produced in the Western States, 53.9% was used directly and the balance, 46.1%, was beneficiated. The weight recovery of the combined beneficiated concentrates and rock used as mined was 60%; P_2O_5 recovery was 77.3%.

Agricultural Products Corp., Monsanto Co., J. R. Simplot Co., and Stauffer Chemical Co. mined and processed phosphate rock in Idaho. In Montana, Cominco American, Inc., and Rocky Mountain Phosphate Co. recovered phosphate rock from underground mines near Garrison. Stauffer Chemical Co. mined phosphate rock in Wyoming and in two areas in Utah. The Meramec Mining Co., Sullivan, Mo., continued to recover apatite concentrates from its Pea Ridge iron ore mine tailings.

There were no new mines started in 1975. Work continued throughout the year on an Environmental Impact Statement by the U.S. Departments of the Interior and Agriculture. It was expected to be finalized and filed with the Council on Environmental Quality in mid-1976. The Statement was initiated in anticipation of development of new mines or expansion of existing phosphate mines in southeastern Idaho in the Caribou National Forest.

Tennessee.—Production of marketable phosphate rocks was 2,291,000 tons, a decrease of 120,000 tons or 5.0% less than reported in 1974. The value of the marketable rock increased from $18,465,000 in 1974 to $28,803,000 in 1975, an increase of 56.0%.

The average grade of mined ore was 19.9% P_2O_5, the average weight recovery of concentrates was 56.5%; recovery of P_2O_5 was 72.8%. A small quantity of rock was mined by several companies and used in electric furnaces without beneficiation.

Hooker Chemical & Plastic Corp., Monsanto Industrial Chemical Co., Stauffer Chemical Co., M. C. West, Inc., and the Tennessee Valley Authority mined phosphate rock in Tennessee and reduced the rock in electric furnaces to elemental phosphorus.

Table 2.—Production of phosphate rock in the United States, by State
(Thousand short tons and thousand dollars)

	Mine production		Mine production used directly		Washer production		Marketable production		
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Value
1974:									
Florida and North Carolina	142,128	17,712	38	8	36,942	11,611	36,980	11,619	408,979
Tennessee	4,135	821	W	W	W	W	2,411	648	18,465
Western States [1]	9,584	2,220	4,111	1,086	2,184	700	6,295	1,786	73,985
Total	155,847	20,753	4,149	1,094	39,126	12,311	45,686	14,053	501,429
1975:									
Florida and North Carolina	173,761	20,493	28	6	40,671	12,748	40,699	12,754	1,000,352
Tennessee	4,052	808	283	67	2,008	520	2,291	588	28,803
Western States [1]	9,702	2,182	3,138	834	2,687	852	5,825	1,686	93,029
Total [2]	187,516	23,483	3,449	907	45,366	14,121	48,816	15,028	1,122,184

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Arkansas (1975), Idaho, Missouri, Montana, Utah, and Wyoming.
[2] Data may not add to totals shown because of independent rounding.

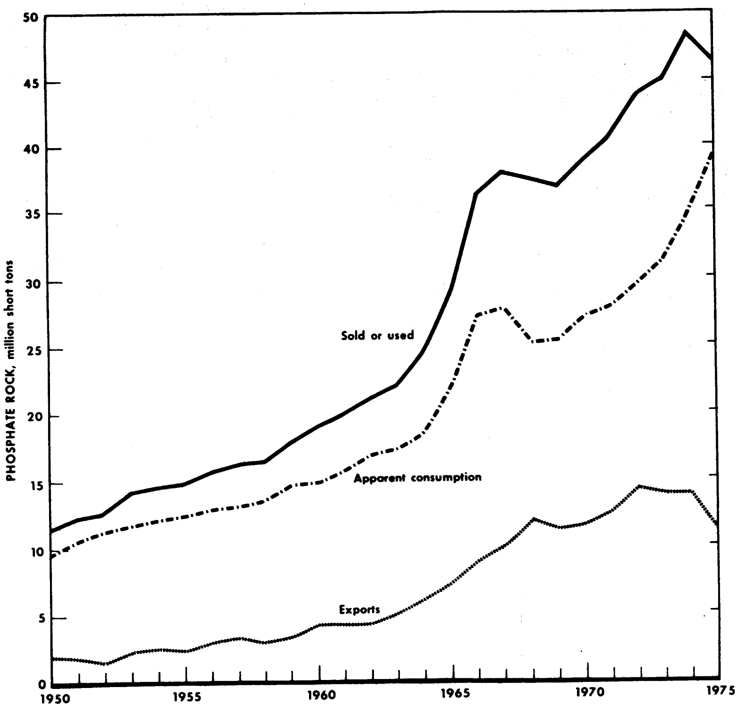

Figure 1.—Phosphate rock (sold or used), apparent consumption, and exports.

CONSUMPTION AND USES

Apparent consumption of marketable phosphate rock, as measured by sold or used, plus imports and less exports, declined 1.5% from that of 1974. According to producers' reports, the quantity of phosphate rock sold or used in 1975 was 46,439,000 tons, a decline from the peak 48,435,000 tons sold or used in 1974. Of the total sold or used in 1975, 73.6% was consumed domestically and 26.4% was exported.

The consumption pattern as reported by producers is shown in table 3. Of the total sold or used including both domestic and export markets, the distribution pattern was wet-process phosphoric acid 55.0%, normal superphosphate 2.2%, triple superphosphate 3.5%, defluorinated rock 0.4%, direct applications 0.3%, and elemental phosphorus and ferrosphosphorus 12.2% for a total of 73.6%.

The percent distribution by grade of marketable rock consumed in the United States and exported is compared with the percent distribution in 1973 and 1974 in the following tabulation:

Grade, BPL content [1]	Distribution (%) 1973	1974	1975
Less than 60%	8.7	5.6	9.4
60%–66%	11.9	20.8	14.7
66%–70%	40.9	42.0	48.4
70%–72%	12.3	12.2	10.8
72%–74%	16.7	11.6	10.7
Over 74%	9.5	7.8	6.0

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Florida and North Carolina.—The quantity of phosphate rock sold or used decreased from 39,920,000 tons in 1974 to 37,921,272 tons in 1975. Of the total sold or used in 1975, 70.6% was consumed domestically and 29.4% was exported. Of that consumed domestically, 88.1% (23,600,000 tons) was used to produce wet-process phosphoric acid, 3.8% (1,008,000 tons) for normal superphosphate, 5.5% (1,487,000 tons) for triple superphosphate, 0.6% (168,000 tons) for defluorinated rock, 0.5% (133,824 tons) for direct applications, 1.4% (389,000 tons) for elemental phosphorus, and less than 0.1% for ferrophosphorus.

The percent distribution by grade of marketable rock sold or used from Florida and North Carolina in 1973, 1974, and 1975 is shown in the following tabulation:

Grade, BPL content [1]	Distribution (%) 1973	1974	1975
Less than 60%	0.3	0.2	0.1
60%–66%	9.7	17.0	14.8
66%–70%	45.9	47.2	55.0
70%–72%	14.1	14.3	11.2
72%–74%	18.5	11.9	11.5
Over 74%	11.5	9.4	7.4

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Western States.—The quantity of marketable rock sold or used in 1975 increased 3.7% compared with 1974. Of the total sold or used in 1974, 81.4% was consumed in the United States and 18.6% was exported.

Of that consumed in the United States, expressed as a percent of the total sold or used from the Western States, 31.7% (1,944,000 tons) was used for wet-process phosphoric acid, 0.1% (8,000 tons) for normal superphosphate, 2.3% (140,000 tons) for triple superphosphate, 0.1% (4,000 tons) for defluorinated rock, less than 0.1% (1,501 tons) for direct applications, and 47.2% (2,890,000 tons) for elemental phosphorus and ferrophosphorus production.

The percent distribution by grade of marketable rock sold or used from the Western States in 1973, 1974, and 1975 is shown in the following tabulation:

Grade, BPL content [1]	Distribution (%) 1973	1974	1975
Less than 60%	37.7	35.8	38.8
60%–66%	22.8	22.5	13.2
66%–70%	20.4	23.5	25.9
70%–72%	6.0	3.5	12.2
72%–74%	12.6	14.3	9.9
Over 74%	.5	.4	--

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Tennessee.—The quantity of marketable rock sold or used declined from 2,607,000 tons in 1974 to 2,393,000 tons in 1975. All of this rock was consumed in electric furnaces to produce elemental phosphorus and industrial chemicals. Most of the elemental phosphorus was converted to furnace-grade phosphoric acid, the base for sodium tripolyphosphate and dicalcium phosphate. A small quantity of elemental phosphorus was converted to anhydrous derivatives.

The percent distribution by grade of marketable rock sold or used from Tennessee in 1973, 1974, and 1975 is compared in the following tabulation:

Grade, BPL content[1]	Distribution (%) 1973	1974	1975
Less than 60%	66.4	19.7	80.9
60%–66%	19.8	75.6	17.5
66%–70%	12.9	4.7	1.6
70%–72%	--	--	--
72%–74%	.9	--	--
Over 74%	--	--	--

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Table 3.—Phosphate rock sold or used by producers in the United States, by use in 1975

(Thousand short tons)

Use	Rock	P_2O_5 content
Domestic:		
Wet process phosphoric acid	25,543	7,891
Normal superphosphate	1,017	315
Triple superphosphate	1,627	535
Defluorinated rock	172	59
Direct applications	39	135
Elemental phosphorus } Ferrophosphorus	5,673	1,477
Total[1]	34,167	10,315
Exports	12,272	3,955
Grand total	46,439	14,270

[1] Data may not add to totals shown because of independent rounding.

Table 4.—Phosphate rock sold or used by producers in the United States, by grade and State in 1975

(Thousand short tons and thousand dollars)

Grade, BPL[1] content	Florida and North Carolina: Rock	P_2O_5 content	Value	Tennessee: Rock	P_2O_5 content	Value
Below 60%	38	8	658	1,936	483	23,709
60%–66%	W	W	W	W	W	W
66%–70%	20,867	6,453	455,732	W	W	W
70%–72%	W	W	W	--	--	--
72%–74%	W	W	W	--	--	--
Plus 74%	2,820	977	99,369	--	--	--
Total[2]	37,921	11,894	927,316	2,393	617	29,921

Grade, BPL[1] content	Western States: Rock	P_2O_5 content	Value	Total United States[2]: Rock	P_2O_5 content	Value
Below 60%	2,378	602	23,343	4,351	1,093	47,710
60%–66%	805	227	10,822	6,818	1,964	117,697
66%–70%	W	W	W	22,487	6,952	489,243
70%–72%	W	W	W	4,993	1,617	143,165
72%–74%	W	W	W	4,969	1,667	155,811
Plus 74%	--	--	--	2,820	977	99,369
Total[2]	6,124	1,758	95,759	46,439	14,270	1,052,995

W Withheld to avoid disclosing individual company confidential data.
[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Data may not add to totals shown because of independent rounding.

Table 5.—Phosphate rock sold or used by producers, by use and State

(Thousand short tons)

Use	Florida and North Carolina		Tennessee		Western States		Total[1] United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1974								
Domestic:								
Agricultural	26,621	8,272	--	--	1,991	639	28,612	8,911
Industrial	W	W	2,607	708	W	W	5,926	1,567
Total domestic	26,621	8,272	2,607	708	1,991	639	34,538	10,478
Exports[2]	W	W	--	--	W	W	13,897	4,468
Total	39,920	12,555	2,607	708	5,908	1,683	48,435	14,946
1975								
Domestic:								
Agricultural	26,397	8,169	--	--	2,097	670	28,494	8,838
Industrial	390	115	2,393	617	2,890	745	5,673	1,477
Total domestic[1]	26,786	8,284	2,393	617	4,987	1,415	34,167	10,315
Exports[2]	11,135	3,610	--	--	1,137	345	12,272	3,955
Total[1]	37,921	11,894	2,393	617	6,124	1,760	46,439	14,270

W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.
[2] Exports reported to Bureau of Mines by companies.

Table 6.—Florida phosphate rock sold or used by producers, by type

(Thousand short tons and thousand dollars)

Year	Land pebble[1]				Soft rock				Total[2]			
	Rock	P_2O_5 content	Value		Rock	P_2O_5 content	Value		Rock	P_2O_5 content	Value	
			Total	Average per ton			Total	Average per ton			Total	Average per ton
1971	33,176	10,621	173,950	$5.24	20	4	141	$7.19	33,195	10,625	174,091	$5.24
1972	36,913	11,863	188,205	5.10	21	4	121	5.87	36,934	11,868	188,326	5.10
1973	36,894	11,716	205,328	5.57	22	4	154	7.00	36,916	11,720	205,482	5.57
1974	39,879	12,547	436,587	10.95	41	8	571	13.93	39,920	12,555	437,158	10.95
1975	37,893	11,888	926,813	24.46	28	6	503	17.96	37,921	11,894	927,316	24.45

[1] Includes North Carolina.
[2] Data may not add to totals shown because of independent rounding.

Table 7.—Tennessee phosphate rock sold or used by producers

(Thousand short tons and thousand dollars)

Use	Rock	P_2O_5 content	Value	
			Total	Average per ton
1971	2,596	687	12,281	$4.73
1972	2,240	587	11,188	4.99
1973	2,665	699	13,812	5.18
1974	2,607	708	20,594	7.90
1975	2,393	617	29,921	12.50

STOCKS

Stocks of marketable phosphate rock in the United States increased from 6,974,524 tons at the beginning of the year to 9,946,045 tons at yearend. The increase returned stocks to 1973 levels, replacing heavy stock drawdowns in 1974.

In Florida and North Carolina, stocks increased from an abnormal low of 5,578,446 tons at the beginning of the year to 8,533,323 tons at yearend. In Tennessee, stocks increased from 275,803 tons to 307,364 tons during the year. In the Western States, stocks were rather stable, decreasing from 1,120,275 tons to 1,105,358 tons during the year.

PRICES

Prices for the various grades of phosphate rock sold in the domestic market are not published by either producers or consumers. Contracts are negotiated between buyer and seller, and terms are not standard. Some companies that sell merchant rock domestically publish prices that, when compared, show differences particularly between phosphate rock sold from different producing areas in the country. The Chemical Marketing Reporter publishes prices for various grades of Florida land-pebble phosphate rock and an example of the price schedule is shown in table 8. These prices may be an indication of the December 1976 new contract price levels in the domestic market.

The price of Western or Tennessee phosphate rock consumed in electric furnaces is not published. Acid-grade rock from the Western States is, for the most part, either captively consumed or exported. Only a small tonnage is sold in the merchant market.

Table 8.—Prices of Florida land-pebble phosphate rock, washed, dried, and unground, in bulk carload lots, f.o.b. mine
(Per short ton)

Grade, BPL content	Price
77%-76%	$52.00
75%-74%	47.00
72%-70%	40.00
70%-68%	35.50
68%-66%	31.00

Source: Chemical Marketing Reporter, v. 208, No. 22, Dec. 1, 1975, p. 48.

The average 1975 unit value[2] of marketable rock as reported by producers, and estimated when unspecified, was $22.99 per ton f.o.b. plant, an increase of 109% over the $10.98 per ton reported in 1974. The average unit value of land-pebble rock reported sold or used in the domestic market from Florida and North Carolina increased from $10.95 per ton in 1974 to $24.46 per ton in 1975. In the Western States, the unit value of marketable rock sold or used increased from $12.08 per ton in 1974 to $15.64 per ton in 1975. The unit value of marketable rock sold or used in Tennessee increased from $7.90 per ton in 1974 to $12.50 per ton in 1975.

The average unit value of phosphate rock exported from the United States increased from $13.96 per ton in 1974 to $34.98 per ton in 1975, a 151% increase. The unit value of marketable rock exported from Florida and North Carolina increased from $13.84 per ton in 1974 to $36.57 per ton in 1975. The unit value of phosphate rock exported from the Western States increased from $16.40 per ton in 1974 to $19.32 per ton in 1975. Tennessee rock was not exported.

The Phosphate Rock Export Association, Tampa, Fla., decreased its prices of phosphate rock on January 1, 1976, from prices that had remained unchanged since October 1, 1974. The prices are shown in table 9.

The Office Cherifien des Phosphates of Morocco increased phosphate rock prices on January 1, 1975, and in October of 1975 started discounting in the range of from $6 to $12 per metric ton in an attempt to stimulate sales. Further price reductions were made effective January 1, 1976, but it was understood that the listed prices were discounted to lower levels for reasons of exclusivity of supply, size of orders, and customer relations. The prices published in Fertilizer International[3] are shown in table 10.

[2] Value, if sold, net selling price f.o.b. plant, or, if used, estimated value from comparable selling prices or developed price; that is, cost plus overhead and profit.

[3] Fertilizer International. Phosphate and OCP Cut Rock Prices. No. 80, February 1976, p. 1.

Table 9.—Florida phosphate rock export price schedule, basis metric ton, unground, f.o.b. vessel Tampa Range or Jacksonville, Fla.

Grade, BPL content	October 1, 1974 [1]	January 1, 1976 [2]
75%	$55.00	$47.00
72%	48.00	41.00
70%	43.00	37.00
68%	39.00	33.00
66%	36.00	30.00

[1] Plus 85 cents severance tax and 45 cents surcharge per metric ton.
[2] Plus 55 cents severance tax per metric ton. The price may be adjusted on individual contracts for freight equalization or other reasons.

Table 10.—Morocco: Phosphate rock export list prices, f.a.s. Casablanca or Safi

Grade, BPL content	Price per metric ton	
	January 1975	January 1976
Khouribga:		
77%	$76.50	$51.50
75%	68.00	48.50
72%	65.00	46.00
Youssoufia:		
72%	60.75	43.00

FOREIGN TRADE

Exports of phosphate rock as reported by producers declined 11.7% to 12,272,000 tons in 1975. Of the total exported in 1975, 90.7% originated in Florida and North Carolina and 9.3% originated in the Western United States. Exports from Florida, the principal source of rock for the export market, declined from the level of shipments made in 1974. Exports from the Western States in 1975 increased 76% over that exported in 1974.

The average calculated unit value of exported phosphate rock in 1975 was $34.98 per ton, considerably greater than the average value of $13.96 per ton reported in 1974.

Imports in 1974 were 36,000 tons, considerably less than the 182,000 tons reported in 1974. The unit value of the imported phosphate rock declined from a high of $49.45 per ton in 1974 to $43.35 per ton in 1975. A small tonnage of rock was imported from Mexico; however, most of the 37,000 tons imported originated in the Netherlands Antilles.

Table 11.—U.S. exports of phosphate rock, by country

(Thousand short tons and thousand dollars)

Destination	1974		1975	
	Quantity	Value	Quantity	Value
Florida phosphate rock:				
Austria	62	622	28	144
Belgium-Luxembourg	1,027	16,607	709	29,641
Brazil	686	15,637	561	24,270
Canada	3,139	40,695	2,623	67,367
Chile	80	3,029	29	1,878
China, People's Republic of	r 45	r 475	--	--
Colombia	103	3,194	48	2,200
Ecuador	14	351	16	709
El Salvador	14	638	5	217
France	348	6,179	572	19,133
Germany, West	942	16,190	589	20,136
India	278	4,575	249	9,655
Iran	408	11,073	415	23,614
Italy	r 497	r 7,573	228	8,540
Japan	2,490	61,058	1,842	80,721
Korea, Republic of	533	9,229	670	30,538
Mexico	966	14,029	1,047	40,141
Netherlands	878	10,874	575	18,822
Norway	98	2,549	83	2,837
Peru	12	260	11	495
Philippines	154	3,319	144	7,232
Poland	302	4,945	466	19,662
Romania	31	677	144	6,216
Spain	r 82	r 1,102	52	1,188
Sweden	72	1,761	69	2,987
Taiwan	62	1,146	16	863
United Kingdom	80	1,666	129	5,673
Other	6	240	1	45
Total	r 13,409	r 239,693	11,321	424,924
Other phosphate rock: [1]				
Argentina	--	--	5	100
Brazil	([2])	1	13	444
Canada	760	14,199	930	21,247
Chile	r 1	188	--	--
Colombia	2	93	--	--
Costa Rica	--	--	11	697
Dominican Republic	3	135	([2])	2
El Salvador	([2])	1	6	383
France	--	--	3	50
Germany, West	27	1,145	16	278
Iran	([2])	2	68	4,096
Japan	--	--	6	195
Mexico	([2])	7	([2])	4
Netherlands	1	19	223	8,483
Peru	--	--	([2])	20
Singapore	3	293	--	--
Taiwan	--	--	3	600
Venezuela	1	37	([2])	2
Other	1	86	1	28
Total	r 799	r 16,206	1,285	36,629
Grand total	r 14,208	r 255,899	12,606	461,553

r Revised.
[1] Includes colloidal and sintered matrix, Tennessee, Idaho, and Montana, and soft phosphate rock.
[2] Less than ½ unit.

Table 12.—U.S. exports of superphosphates, by country
(Thousand short tons and thousand dollars)

Destination	1974		1975	
	Quantity	Value	Quantity	Value
Argentina	9	1,344	5	1,700
Australia	1	52	1	105
Bangladesh	17	5,291	80	9,799
Belgium-Luxembourg	--	--	16	1,814
Brazil	340	70,692	377	55,707
Canada	59	3,850	69	5,410
Chile	194	50,070	67	19,406
Colombia	22	3,192	13	2,855
Costa Rica	4	324	2	525
Dominican Republic	16	2,121	2	813
Ecuador	9	1,820	(1)	4
France	72	5,471	87	7,580
Germany:				
West	11	1,184	40	4,488
East	--	--	6	722
Guyana	4	510	6	1,300
Hong Kong	(1)	2	(1)	10
Hungary	13	1,038	59	6,989
Indonesia	124	25,922	99	26,595
Iraq	--	--	11	3,200
Italy	r 12	r 792	29	2,994
Jamaica	6	758	3	447
Japan	10	1,888	13	2,986
Korea, Republic of	r 117	r 28,313	44	16,121
Mexico	1	99	5	316
New Zealand	7	211	(1)	12
Peru	2	523	12	3,996
Philippines	19	4,367	1	211
Poland	20	1,647	85	8,684
Singapore	4	534	--	--
Spain	--	--	6	141
Sri Lanka	r 24	r 7,872	8	2,051
Taiwan	(1)	2	3	391
United Kingdom	8	664	12	1,177
Venezuela	18	4,562	13	3,080
Other	r 10	r 2,375	6	1,601
Total	r 1,153	r 227,490	1,180	193,230

r Revised.
[1] Less than ½ unit.

Table 13.—U.S. exports of ammonium phosphates, by country

(Thousand short tons and thousand dollars)

Destination	1974 Quantity	1974 Value	1975 [1] Quantity	1975 [1] Value
Afghanistan	--	--	26	7,056
Argentina	34	7,137	9	2,964
Belgium-Luxembourg	55	5,688	29	4,537
Bolivia	1	222	1	284
Brazil	414	72,379	462	77,724
Canada	67	9,173	92	12,811
Chile	84	20,404	37	12,229
Colombia	29	5,174	6	1,358
Costa Rica	30	5,329	19	5,156
Dominican Republic	38	7,142	22	3,931
Ecuador	41	12,876	20	6,993
El Salvador	50	8,300	17	5,808
Ethiopia	--	--	57	10,469
France	125	16,700	161	28,188
Guatemala	14	1,891	(2)	30
India	403	65,606	559	159,326
Indonesia	44	13,669	88	22,975
Iran	16	5,781	141	46,936
Italy	14	1,879	326	51,335
Japan	105	21,847	62	10,919
Kenya	6	2,210	11	1,455
Lebanon	28	7,664	--	--
Libya	--	--	23	4,520
Mexico	5	580	33	6,540
New Zealand	41	4,281	13	2,168
Nicaragua	10	2,316	1	233
Pakistan	12	3,922	6	854
Panama	3	655	(2)	1
Peru	7	1,836	36	11,082
Philippines	22	4,870	11	4,128
Portugal	--	--	16	2,988
Singapore	55	6,913	--	--
Spain	--	--	22	3,332
Thailand	124	16,343	50	10,115
United Kingdom	(2)	6	18	3,210
Uruguay	7	903	20	4,437
Venezuela	25	8,071	--	--
Vietnam, South	67	15,271	13	3,073
Yugoslavia	6	650	--	--
Other	10	1,119	15	3,109
Total	1,992	358,807	2,422	532,274

[1] Beginning January 1, 1975, ammonium phosphates became diammonium phosphates and ammonium phosphate fertilizers.
[2] Less than ½ unit.

Table 14.—U.S. exports of mixed chemical fertilizers, by country

(Thousand short tons and thousand dollars)

Destination	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Belgium-Luxembourg	62	3,091	(1)	12
Brazil	2	1,112	7	1,131
Canada	73	9,790	179	10,424
Colombia	36	6,290	45	12,177
Costa Rica	3	423	5	763
Dominican Republic	2	271	8	1,373
El Salvador	15	1,992	4	560
France	10	580	1	100
Germany, West	4	1,483	4	1,780
Greece	1	195	(1)	124
Guatemala	11	1,906	9	1,795
Italy	20	1,158	11	1,266
Japan	(1)	222	4	284
New Zealand	(1)	50	(1)	41
Nicaragua	23	4,379	5	758
Panama	1	168	12	2,252
Sweden	119	6,534	--	--
Thailand	6	1,354	9	1,448
United Kingdom	(1)	89	(1)	51
Vietnam, South	57	7,164	6	634
Other	29	5,225	15	3,722
Total	474	53,476	324	40,695

[1] Less than ½ unit.

Table 15.—U.S. exports of elemental phosphorus, by country

Destination	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Argentina	1,402	$1,413	600	$1,121
Australia	20	13	683	941
Belgium-Luxembourg	4	1	141	70
Brazil	35	15	65	65
Canada	161	70	1,638	1,095
Chile	1	(1)	22	45
Denmark	450	376	426	515
Egypt	110	220	155	300
Germany, West	260	189	149	170
India	64	152	441	661
Italy	2	1	112	193
Japan	6,990	3,341	3,792	3,263
Malaysia	55	80	110	149
Mexico	23,853	14,088	26,086	25,836
Switzerland	72	52	--	--
United Kingdom	119	62	1,393	2,217
Other	r 93	r 46	32	18
Total	r 33,691	r 20,119	35,845	36,659

r Revised.
1 Less than ½ unit.

Table 16.—U.S. imports for consumption of phosphate rock and phosphatic materials

(Thousand short tons and thousand dollars)

Fertilizer	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Phosphates, crude and apatite	[1] 182	[1] 8,999	37	1,604
Phosphatic fertilizers and fertilizer materials	202	32,512	147	26,970
Ammonium phosphates, used as fertilizers	344	40,509	303	50,640
Bone ash, bone dust, bone meal and bones ground, crude or steamed	6	664	8	1,108
Dicalcium phosphate	7	1,343	(2)	46
Basic slag	(2)	1	(2)	1
Manures including guano	(2)	15	3	43
Phosphorus	1	1,214	1	1,615
Phosphoric acid	2	619	1	231

1 Adjusted by the Bureau of Mines.
2 Less than ½ unit.

WORLD REVIEW

Although plans and projects in some principal producing areas of the world, conceived in prior years, were executed in 1975, others were deferred since demand for phosphate rock was depressed by the continuing high price structures established in 1974 and the disparity between the relatively high world prices of phosphate rock and declining world prices of phosphate fertilizers.

Australia.—Shipments of phosphate rock from the Duchess deposit, located about 27 miles south of Duchess, Queensland, were initiated in March. Duchess is situated about 38 miles southeast of Mount Isa. The mine product was trucked to the railhead at Duchess and loaded into cars for the haul to Townsville on the east coast. The railroad will be extended to the Duchess deposit and when completed in 1976, phosphate rock will be moved by rail from both the Duchess and associated Ardmore deposits at a rate of 1.1 million short tons per year. In 1977, shipments at a rate of 3.3 million short tons per year are planned. The reserves of the Duchess-Ardmore deposits are estimated to be 44 million short tons of direct-shipping ore grading 31% P_2O_5 and 1,500 million short tons grading 17.5% P_2O_5. Development of these deposits will probably delay development of the Lady Annie and Lady Jane phosphate deposits northwest of Mount Isa and closer to the Gulf of Carpentaria.

Canada.—International Minerals & Chemical Corp. reported the discovery of a carbonatite-alkalic rock complex containing apatite in Cargill Township in northern Ontario. The general location is about 28 miles southwest of Kapuskasing and about 400 miles northwest of Toronto. The discovery was described as significant, but additional drilling and analysis must be completed before the deposit can be fully characterized.

Egypt.—Studies of the phosphate rock deposits in the Abu Tartar plateau were reported by the General Organization for Industrialization of the Ministry of Industry and Mineral Wealth. The deposits are west of El Kharga approximately 291 miles south-southwest of Cairo. The Ministry reports nearly 660 million short tons of proven reserves. Various plans have been announced, but not finalized, to develop the deposit, construct a rail line from Abu Tartar spanning the Nile to the Red Sea, and a port on the Red Sea to export phosphate rock or triple superphosphate.

Finland.—The Finnish Government decided to develop phosphate deposits in Savukoski-Sokli to recover 55 million short tons of apatite concentrates. By 1980, production could reach 772,000 short tons per year.

Kemira Oy mined a trial quantity (110,000 short tons) from an apatite deposit in central Finland. An 11-ton-per-day pilot-plant test will determine the feasibility of producing from this deposit on a commercial scale.[4]

Israel.—Negev Phosphates Ltd., a part of Israel Chemicals Ltd., will develop a new mine at Nahal Zin to produce 2 million tons per year of washed phosphate rock. The port of Ashdod will be expanded, a rail line installed to Nahal Zin, brackish water wells drilled, and construction of a washing plant to leach chlorine out of the rock will require a total investment of $85 million. By 1978, Israel will have a total capacity of 3 million tons per year of phosphate rock.[5]

Jordan.—The expansion program at El Hassa and Ruseifa is designed to increase production to 5 million short tons in 1976, 7 million tons in 1977, 8.5 million tons in 1978, and 9.5 million tons in 1979. It is assumed that production will remain at or about this level until 1995. The railroad line from Batn-el-Gul to Aqaba, a distance of 63 miles, can only carry 1.8 million tons per year. Studies are underway to increase the carrying capacity of the railroad from El Hassa to Aqaba, a distance of 142 miles to permit shipments of 5 million tons by 1977 and as much as 8 to 9.5 million tons by 1979.

Mexico.—Since press reports in 1974 of the discovery of 3 billion short tons of phosphate rock in the Baha California peninsula of Mexico, press reports in 1975 indicated reserve estimates to be 500 million tons or 300 million tons; other reports suggested that estimates of the Baha reserves are far from exact at this time.[6]

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[4] Fertilizer International. No. 70, April 1975, p. 4.

[5] Chemical Week. Chemical Resources Sitting on the Crossroads of Three Continents. V. 116, No. 22, May 28, 1975, 10 pp.

[6] Chemical Week. Mexico Taps Phosphate. V. 116, No. 26, June 25, 1975, p. 19.
Industrial Minerals. Implications of Recent Finds. No. 93, June 1975, p. 10.
Wall Street Journal. Mexico to Invest $184 Million in Phosphate Rock Mining. June 16, 1975.

Morocco.—The decline of phosphate rock exports in 1975, compared with those in 1974, was attributed to the higher prices established at the beginning of 1975. The market position in phosphate rock deteriorated steadily throughout the year. In November 1975, Morocco reduced the price of phosphate rock by about $8 per metric ton in an attempt to increase sales. In the short term, because of the depressed market, Moroccan plans to export phosphate rock, phosphoric acid, and solid intermediates were curtailed. If the effort by Morocco's King Hassan II to annex the Spanish Sahara is successful, Morocco will control the world's largest reserves of phosphate rock and improve the long-range prospects of Morocco's position in world trade of this commodity.

Peru.—Plans for the Bayovar fertilizer complex to produce and export phosphatic fertilizers in 1976 were announced. Minero Perú, the State-owned mining company, is expected to furnish raw materials for the production of 838,000 short tons per year of fertilizers. Production will be from 606 short million tons of proven reserves.[7]

Senegal.—President Leopold S. Senghor, in his annual address on March 24, 1975, discussed the development of the new Tobene phosphate rock mine. It is located about 4 miles from the Taiba mine and could open as early as 1978. At least three international corporations are bidding on the construction contract for the mine and plant. Exploration programs to locate phosphate rock in northern, eastern, and southern Senegal were conducted cooperatively in 1975 by the Government of Senegal, United States Steel Corp. Phosphates de Thies, and the Bureau de Recherches Géologiques et Minières.

Spanish Sahara.—The Spanish Government began moving troops out of the Spanish Sahara at yearend. After the Moroccan army moved into the capital city and surrounding areas, a civil administration was organized.[8] With the Spanish presence in the Spanish Sahara ended, Morocco will operate the Bu Craa mine and plant. Arrangements with Spain were not announced; however, speculation suggests that Spain will continue to receive phosphate rock from Bu Craa. Reserves previously estimated by Fosfatos de Bu Craa S.A. to be 1.9 billion short tons were increased to 10 billion tons by new discoveries.[9]

Syrian Arab Republic.—Syria concluded an agreement with Romania to conduct a survey and estimate reserves of phosphate rock in the Syrian desert. Romania will also construct a plant to process phosphate rock in 1977. The Syrian Government forecast that production will increase to more than 3 million tons per year by 1980. It will be necessary to construct a railway system to transport phosphate rock from the mines to ports on the Mediterranean Sea.[10]

Tunisia.—Compagnie des Phosphates et du Chemin de Fer de Gafsa's new mine at Sehib, southwest of Gafsa in central Tunisia, was scheduled to start production in 1976. Reserves have been estimated to exceed 66 million short tons. Each of three planned longwall faces will have a capacity of 2,200 short tons per day. Initial production will be 1.3 million short tons per year. In addition to developing the Sehib mine, Sfax-Gafsa Co. is also developing the M'rata and Kev es Schfair mines in the Gafsa Phosphate Basin. Completion of these programs will increase Tunisian phosphate rock capacity from 4.4 to 5.7 million short tons in 1978.[11]

U.S.S.R.—The first commercial exploitation of the Kovdor apatite deposit on the Kola peninsula began with the startup of a 970,000-ton-per-year concentration plant.[12]

A large deposit, estimated to contain 3 billion tons of phosphate rock, was reportedly discovered in Yakutia in eastern Siberia. If fertilizers are produced from this deposit, the need to ship similar materials from the Urals and European U.S.S.R. would diminish.[13]

[7] Chemical Age. Peru Plans Big Phosphate Export Boost. V. 110, No. 2917, 1975, p. 11.
[8] New York Times. Morocco Administers the Sahara Area as Spanish Troops Leave. Jan. 11, 1976.
[9] Chemical Week. Spanish Sahara Poke May Hold a Bigger Prize. Nov. 26, 1975, p. 25.
[10] Chemical Age. Syria Sees Big Build Up in Phosphate Exports. V. 110. No. 2915. 1975 p. 9.
[11] Industrial Minerals. Gafsa's New Phosphate Mine. No. 93, June 1975 pp. 11–12.
[12] Industrial Minerals. Company News & Mineral Notes. No. 89, February 1975, p. 45.
[13] European Chemical News. USSR Discovers Major New Phosphate Deposits. V. 27, No. 689, June 6, 1975, p. 8.

Table 17.—Phosphate rock: World production, by country

(Thousand short tons)

Country [1]	1973	1974	1975 [p]
North America:			
United States	42,137	45,686	48,816
Mexico	79	214	311
Netherlands Antilles	102	118	90
South America:			
Argentina (guano)	1	[e] 1	[e] 1
Brazil	[r] 283	244	380
Chile (guano)	14	21	15
Colombia	11	11	1
Peru [e]	25	25	22
Venezuela	33	156	171
Europe:			
France	[r] 25	21	[e] 20
Germany, West	102	94	83
U.S.S.R. [e 2]	23,400	24,800	26,600
Africa:			
Algeria	[r] 710	797	779
Egypt	610	559	445
Morocco	18,824	21,739	14,934
Rhodesia, Southern [e]	165	145	145
Senegal:			
Aluminum phosphate	241	447	222
Calcium phosphate	1,690	1,623	1,764
Seychelles Islands (guano)	[e] 8	[3] 8	[e] 8
South Africa, Republic of	1,505	1,437	1,955
Spanish Sahara	768	2,630	2,956
Togo	2,527	2,835	1,279
Tunisia	[r] 3,829	4,218	3,845
Uganda [e]	17	17	17
Asia:			
China, People's Republic of [e]	3,300	3,300	3,700
Christmas Island (Indian Ocean)	1,695	1,945	1,534
India:			
Apatite	11	13	27
Phosphate rock	[r] 150	475	473
Israel	860	1,131	[e] 1,010
Jordan	[r] 1,191	1,846	1,491
Korea, North (apatite) [e]	400	440	500
Philippines:			
Guano	(4)	15	139
Phosphate rock	13	29	6
Syrian Arab Republic	165	664	945
Vietnam, North [e]	550	1,300	1,500
Oceania:			
Australia	[r] 1	2	143
Nauru Island	2,561	2,522	1,690
Ocean Island	820	619	569
Total	[r] 108,823	122,147	118,586

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, Belgium, Indonesia and Tanzania may have continued to produce phosphate rock, and South West Africa produced guano, but output is not officially reported and available information is inadequate for formulation of reliable estimates of output levels.

[2] Estimate by International Superphosphate Manufacturer's Association, on the basis of a marketable product averaging 34.8% P_2O_5; differs with data reported in the U.S.S.R. chapter of Volume III of the Minerals Yearbook which are reported in terms of two products of differing grade.

[3] Exports.

[4] Less than ½ unit.

TECHNOLOGY

The Albany Metallurgy Research Center of the Federal Bureau of Mines, Albany, Oreg., initiated a program to develop new procedures for recovering phosphorus from the complex phosphate rock deposits located in the Western United States. A number of phosphate beds were identified and sampled for beneficiation studies. One sample from the Dry Valley area of Idaho was characterized as a low-grade phosphatic shale, averaging 11 feet in thickness and assaying 10% to 11% P_2O_5. Another sample from the Conda, Idaho, area was somewhat higher in P_2O_5 content and had an unusually high carbon content, ranging from 11% to 16%. A third sample from the Sublette Range area on the Idaho-Wyoming border was obtained and beneficiated. Characterization and beneficiation studies of these materials include attrition-scrubbing-sizing, washing and sizing, calcining, and grinding and flotation circuits. A 60-pound-per-hour continuous-circuit beneficiation plant was constructed and some shakedown tests were made. Startup problems will be corrected, and the plant will be used to evaluate a combination carbonate-silica flotation circuit on mixed altered-unaltered phosphate rock.

The Albany Metallurgy Research Center also designed and assembled a continuous unit to demonstrate production of phosphoric acid by direct sulfuric acid digestion of Florida land-pebble matrix samples. The goals were to produce phosphoric acid with improved P_2O_5 recovery without creating the difficult-to-dewater slime normally generated in washing and classifying Florida phosphate-bearing matrix. In initial tests, conditions were established in the sulfuric acid digestion reactor to promote large crystals of gypsum and increase filtration rates. This was accomplished by increasing the digestion temperature from 60° C to 90° C and controlling the sulfate level in the slurry. The phosphoric acid derived from matrix digestion approximated the composition of commercial acid produced from phosphate rock concentrates except for the aluminum content, which was about double that of commercial acid. Purification of the acid produced by matrix digestion to a quality equivalent to commercial acid has not been achieved. Preliminary studies utilizing ion-exchange systems and precipitation procedures were inconclusive.

Studies at the Bureau of Mines Tuscaloosa Metallurgy Research Laboratory, Tuscaloosa, Ala., to investigate the effects of reagents on settling rates, gelation, and dewatering behavior of Florida phosphate slimes continued in 1975. The effects of organic, inorganic, and commercial reagents on high-grade attapulgite slime from the Florida field were measured at different reagent concentrations. Measurements of viscosity and conductivity were made, and the reagent-slime mixtures were adjusted to different pH levels with sodium hydroxide and hydrochloric acid prior to centrifuging to simulate a 30-day settling test. The dewatering effect was generally unsatisfactory, conforming to the results of prior tests with various reagents and pH modifications. In another series of tests, reagents were mixed with waste tailings sand, then added to a plant slime and allowed to settle. A number of reagents were tested with this procedure, but the best results were obtained when flocculant AP-30 was used.

A thick stringy mixture was formed when attapulgite slime was mixed with a polyethylene oxide polymer. When this mixture was combined with a second reagent, the system released more than 90% of its water as a clear liquid. A coherent plastic mass containing the slime solids remained. Laboratory tests indicated that this result could be achieved with a polymer addition of 7.7 pounds per ton.

The correlation of slime composition and filtration behavior was studied. A procedure developed by modifying an American Petroleum Institute standard method for evaluating drilling muds was used as a rapid test for studying relative filtration rates of clay mineral combinations that occur in Florida phosphate slimes. It was found that montmorillonite suspensions filter very slowly and attapulgite and kaolinite suspensions filter rapidly. The variation in filtration rates was probably a result of the closely stacked structure of plates and sheets of montmorillonite, the needlelike structure of attapulgite, and the hexagonal flaky structure of kaolinite. Because of the similarity in filtration behavior of attapulgite and kaolinite suspensions, a number of electrolytes were evaluated for their effect on the filtration of kaolinite suspensions. Calcium salts, especially CaO, were most effective on the filtration rate of kaolinite suspensions.

Static filtration, wicking, and compaction methods of dewatering Florida phosphate slimes were investigated. Laboratory studies utilizing a column of moving screens was effective when the experiment was performed in two stages. With slimes containing from 4% to 7% solids, solid concentrations of from three to five times the original were achieved. A serious disadvantage to this procedure is the difficulty of applying the technique on a commercial-plant scale. Static filtration was found to be effective. Newspapers were wrapped around wire screen cylinders and immersed vertically in the slime. This type of system could be used to dewater existing slime ponds. After 2 weeks, the percent solids increased to 25. Dewatering slimes to 35% solids was accomplished by electro-dewatering procedures. In wicking or static filtration tests, individual wicks did not appear to dewater a very large area. This type of system, with wicks molded with resin-sand mixtures, may have potential for larger scale field tests.

Samples of the Florida Hawthorn Formation were obtained for characterization studies, and some beneficiation tests of selected samples were conducted. After removing primary slimes, the ore was ground to pass 150 mesh and again deslimed. The pulp was conditioned with phosphoric acid to depress the phosphate and a fatty acid to float the dolomite. Recovery was very low, and the tailings, after cationic flotation of the insoluble material, analyzed 27.3% P_2O_5, 45.1% CaO, and 1.6% MgO. Additional tests showed that improved results were obtained when the ore was ground to pass 65 mesh, deslimed at 200 mesh with a loss of 60% of the original sample weight and thickened to 65% solids. After conditioning with a fatty acid-mineral oil combination, a rougher phosphate concentrate was floated that analyzed 31.8% P_2O_5. Preliminary tests indicated that after dolomite removal, the phosphate will respond to single-stage flotation without depressants. In future tests, only Hawthorn Formation samples that have 5% or more P_2O_5 will be tested.

At the annual meeting of the Fertilizer Industry Round Table in Washington, D.C., in December, Davy Powergas Inc., of Lakeland, Fla., was presented with the John C. Vaaler award for its wet-grinding process for phosphate rock. The process eliminates the need to dry the rock and saves 2.5 gallons of fuel oil per ton of rock. In addition, a smaller mill can be used, dust pollution is eliminated, and dust-collecting systems are not required, further reducing power costs and investment dollars.

Two large slurry-handling systems are now in use for storing and reclaiming phosphate ore at the Phosphoria and Noralyn, Fla., operations of International Minerals & Chemical Corp. Developed by Marconaflo Inc., a subsidiary of Marcona Corp., San Francisco, Calif., the slurry-handling systems are capable of handling more than 10 million tons per year of washed phosphate flotation plant feed and provide a continuous slurry flow at a controlled solids content (around 40%), independent of fluctuations in the output of the mining and washing operations, which can adversely affect production, especially at times of peak demand.

At each site there are two large ponds, each about 300 feet across and 25 feet deep, separated by a central dam. While phosphate slurry is being withdrawn from one pond, the other is being filled with slurry from the washing plant and free water allowed to drain off. Recovery is effected by a high-powered water jet that can be projected horizontally for distances up to 100 feet from a special assembly on the floor of each pond. This undercuts the material, and the slurry flows to a sump around the jet assembly from which it is pumped to the flotation plant. Total storage capacity at each site is about 60,000 short tons. The system acts as a surge between the mine and washing plant and the flotation system.

The Marconaflo concept may find wider use in the phosphate industry. There is interest in long-distance slurry transport of mined phosphate rock where rail construction costs would be prohibitive. It has been proposed that the production be moved via pipeline from Queensland Phosphate's Lady Annie/Lady Jane project to Sweers Island.[14]

[14] Phosphorus & Potassium. Slurry Handling System in Use at IMC Florida Phosphate Facilities. No. 79, September–October 1975, pp. 40–41.

Platinum-Group Metals

By W. C. Butterman [1]

In the United States, mine production rose by nearly 49% above that of 1974, to 18,920 ounces, while refinery production, including both toll and nontoll metal and derived almost entirely from secondary materials, fell 9%, to 1.3 million ounces. Sales of metal to industry dropped by 671,000 ounces, to 1.3 million ounces, or 34% below the 1974 level. Industry stocks dropped 24% to 849,000 ounces. Exports decreased 21% to 660,000 ounces, and imports decreased 44% to 1.8 million ounces.

World mine production of the platinum-group metals in 1975 remained at 5.8 million troy ounces, the level of 1974, as increases in nickel-byproduct production in Canada and the U.S.S.R. offset a production decrease in the Republic of South Africa. These three countries accounted for more than 99% of world mine production. The small remainder came from seven countries, including the United States. Demand for the platinum-group metals decreased in 1975 owing to economic recession in the industrialized countries. Demand for platinum in Japan countered the trend, however, so that Japanese consumption of platinum-group metals grew 14% in 1975. It was estimated that about one-third of the world's platinum-group metals was consumed by Japan, almost another third by the United States, and the remainder shared about equally between other market economy countries, and the centrally controlled economy countries.

Table 1.—Salient platinum-group metals [1] statistics
(Troy ounces)

	1971	1972	1973	1974	1975
United States:					
Mine production [2]	18,029	17,112	19,980	12,657	18,920
Value	$1,359,675	$1,267,298	$2,103,704	$1,932,203	$2,280,200
Refinery production:					
New metal	21,184	15,380	19,916	13,234	16,571
Secondary metal	278,175	255,641	265,901	325,216	270,101
Toll-refined new and secondary metal	1,452,838	1,361,623	1,039,189	1,088,022	1,016,968
Total refined metal	1,752,197	1,632,644	1,325,006	1,426,472	1,303,640
Exports (except manufactures)	404,610	538,994	627,526	835,754	659,885
Imports for consumption	1,388,043	1,892,184	2,504,181	r 3,251,311	1,820,284
Stocks Dec. 31: Refiner, importer, dealer	796,791	930,853	1,033,124	r 1,121,806	849,210
Consumption	1,261,312	1,562,245	1,833,901	1,981,010	1,310,037
World: Production	4,084,110	4,269,990	r 5,232,149	r 5,773,739	5,766,894

r Revised.
[1] The platinum group comprises six metals: Platinum, palladium, iridium, osmium, rhodium, and ruthenium.
[2] Recovered from platinum placers and as byproducts of copper refining.

Legislation and Government Programs.—U.S. Government inventories of platinum, palladium, and iridium remained unchanged in 1975. The three metals were in excess of stockpile objectives established in 1973. The Environmental Protection Agency held hearings on automotive emission standards and technology early in the year, and shortly thereafter announced a further 1-year delay, through model year 1977, in the application of the original 1975 standards.

[1] Physical scientist, Division of Nonferrous Metals.

Table 2.—U.S. Government inventory of platinum-group metals, December 31, 1975
(Troy ounces)

	Platinum	Palladium	Iridium
National stockpile	[1]402,646	[2]507,314	[3]17,002
Supplemental stockpile	49,999	747,680	--
Total	452,645	1,254,994	17,002
Objective	1,314,000	2,450,000	97,761

[1] Includes 13,043 troy ounces non-stockpile-grade material.
[2] Includes 2,204 troy ounces non-stockpile-grade material.
[3] Includes 12 troy ounces non-stockpile-grade material.

DOMESTIC PRODUCTION

Domestic mine production of the platinum-group metals in 1975 was 18,920 ounces. Most of the metal was recovered as a byproduct of copper refining; the remainder came from a placer deposit at Goodnews Bay, Alaska, the only domestic deposit mined primarily for the platinum-group metals.

U.S. refinery production, including toll-refined metal, was 1.3 million ounces. Of this, 97% was secondary metal. The quantity of secondary metal refined on a nontoll basis was 270,000 ounces, while tolled secondary metal, always a much larger quantity, amounted to about 1.0 million ounces. The small quantity of primary metal was derived from crude platinum from Alaska and from anode slimes produced in the electrolytic refining of copper from the Western States. Compared with 1974 levels, mine production in 1975 rose 49% while total refinery production fell 9%. The quantity of secondary material refined on a nontoll basis declined 17%, and tolled secondary material fell 6%.

The Johns-Manville Corp. continued exploration and development of claims in the Beartooth Mountains of southern Montana. Grade in the mineralized horizon averaged 0.43 to 0.46 ounce of platinum plus palladium per ton, with 0.15% copper plus nickel. The ratio of platinum to palladium in samples was about 1 to 3.5. Feasibility studies were expected to be completed by mid-1976.[2]

[2] Engineering and Mining Journal. Johns-Manville Gets Good Assays From Montana Platinum-Palladium Prospect. V. 177, No. 2, February 1976, p. 17.

Table 3.—Platinum-group metals refined in the United States
(Troy ounces)

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
PRIMARY METAL							
Nontoll-refined:							
1971	10,198	10,237	498	154	83	14	21,184
1972	3,708	10,836	594	173	62	7	15,380
1973	5,560	13,121	957	176	88	14	19,916
1974	4,103	8,634	381	72	38	6	13,234
1975	5,292	10,968	236	44	28	3	16,571
Toll-refined:							
1971	156,599	66,467	2,491	161	8,118	14	233,850
1972	54,773	23,752	1,751	111	3,354	478	84,219
1973	32,883	3,972	1,158	102	381	70	38,566
1974	16,293	2,784	742	96	185	7	20,107
1975	14,619	2,002	373	15	164	1	17,174
SECONDARY METAL							
Nontoll-refined:							
1971	103,429	161,099	2,186	352	8,837	2,272	278,175
1972	75,942	162,718	4,393	149	11,390	1,049	255,641
1973	94,884	150,019	6,785	20	11,561	2,632	265,901
1974	95,999	213,416	3,494	6	11,127	1,174	325,216
1975	103,623	149,552	2,300	44	13,683	899	270,101
Toll-refined:							
1971	625,649	527,375	9,572	4,008	43,173	9,211	1,218,988
1972	787,697	431,248	7,717	1,520	44,065	5,157	1,277,404
1973	581,005	373,396	3,395	1,292	36,865	4,670	1,000,623
1974	654,156	365,779	3,465	1,447	36,196	6,872	1,067,915
1975	541,930	383,501	10,424	1,263	43,137	19,539	999,794
1975 TOTALS							
Total primary refined	19,911	12,970	609	59	192	4	33,745
Total secondary refined	645,553	533,053	12,724	1,307	56,820	20,438	1,269,895
Grand total refined	665,464	546,023	13,333	1,366	57,012	20,442	1,303,640

CONSUMPTION AND USES

Sales of the platinum-group metals to U.S. industry totaled 1.3 million ounces in 1975. The automotive industry was the largest purchaser, accounting for 28% of total purchases, followed by the chemical industry (24%), the electrical industry (17%), the dental-medical industry (10%), the petroleum refining industry (9%), and other industries (12%). Compared with 1974 levels, sales of the whole group in 1975 were down 671,000 ounces, or 34%. As shown in table 4, platinum sales at 699,000 ounces comprised 53% of total sales, followed by palladium (542,000 ounces), 41%; rhodium, 3%; ruthenium, 2%; and iridium, 1%.

In general, the uses of the platinum-group metals remained the same as in previous years, those uses being related to the outstanding catalytic activity, refractoriness, and resistance to chemical corrosion possessed by the six metals of the group. However, the pattern of usage of palladium, which had changed in 1974 with the advent of automotive emissions control catalysts and the replacement by the telephone industry of pure palladium relay contacts with palladium-silver contacts, changed further as the full impact of the telephone industry's reduced consumption was felt. Although automotive industry purchases of palladium and platinum declined in 1975, the quantity of metal actually consumed, as distinguished from being put into inventory, was larger in 1975 than in 1974.

Table 4.—Platinum-group metals[1] sold to consuming industries in the United States

(Troy ounces)

Year and industry	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1971	426,684	760,106	15,512	2,126	34,366	22,518	1,261,312
1972	545,299	876,024	37,754	2,397	46,095	54,676	1,562,245
1973	658,533	1,012,484	30,676	1,629	73,515	57,064	1,833,901
1974:							
Automotive	350,000	150,000	--	--	--	--	500,000
Chemical	215,663	163,205	7,334	981	23,328	16,305	426,816
Dental and medical	25,513	124,074	325	687	373	236	151,208
Electrical	98,608	390,237	2,840	55	15,538	43,916	551,194
Glass	74,398	9,549	353	--	7,464	351	92,115
Jewelry and decorative	22,968	21,701	884	--	10,460	2,240	58,253
Petroleum	139,519	14,877	9,970	--	1,239	--	165,605
Miscellaneous	17,020	12,420	1,072	--	3,200	2,107	35,819
Total	943,689	886,063	22,778	1,723	61,602	65,155	1,981,010
1975:							
Automotive	273,000	97,000	--	--	--	--	370,000
Chemical	148,813	142,975	2,559	414	15,440	5,457	315,658
Dental and medical	17,097	114,970	54	669	41	144	132,975
Electrical	73,624	132,247	1,969	--	8,252	10,638	226,730
Glass	33,813	17,633	207	--	4,471	183	56,307
Jewelry and decorative	22,900	23,026	401	--	4,932	1,156	52,415
Petroleum	107,988	2,255	3,587	--	114	820	114,764
Miscellaneous	21,318	11,942	366	1	3,598	3,963	41,188
Total	698,553	542,048	9,143	1,084	36,848	22,361	1,310,037

[1] Comprises primary and nontoll-refined secondary metals.

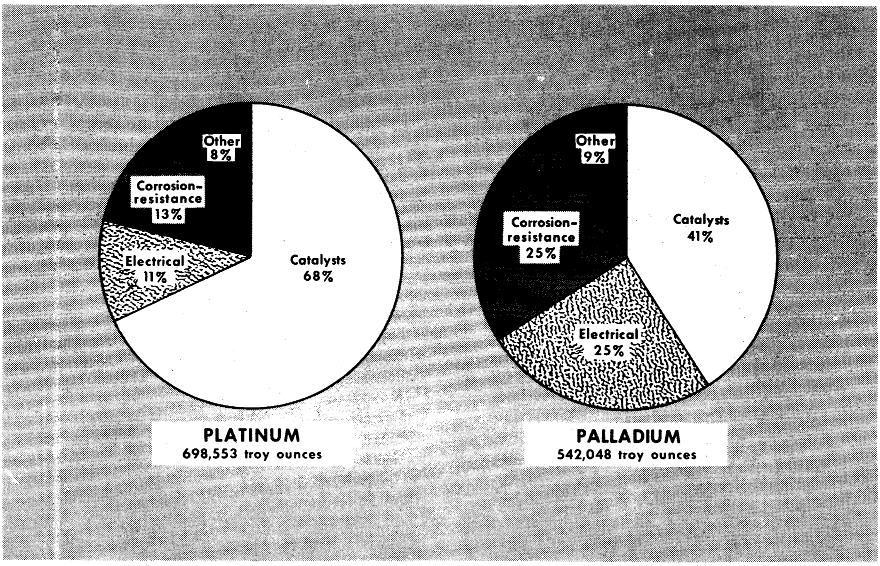

Figure 1.—Uses of platinum and palladium in 1975.

STOCKS

Stocks of platinum-group metals held by refiners, importers, and dealers decreased 24% in 1975. Iridium stocks remained essentially unchanged from 1974 levels, but stocks of the other metals declined as follows: Platinum 21%; palladium 30%; osmium 28%; rhodium 3%; and ruthenium 44%. (It should be noted that these are partial industry stocks, since the Bureau of Mines does not collect inventory data from end users of the platinum-group metals, some of whom may hold sizable inventories). In addition, there were Government stockpiles of platinum, palladium, and iridium.

Table 5.—Refiner, importer, and dealer stocks of platinum-group metals in the United States, December 31 [1]

(Troy ounces)

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1971	385,828	316,126	16,434	604	51,529	26,270	796,791
1972	426,611	405,793	14,987	82	56,967	26,413	930,853
1973	446,522	493,078	14,813	327	51,504	26,880	1,033,124
1974 r	532,675	478,210	18,159	869	55,791	36,102	1,121,806
1975	420,770	335,621	18,276	627	53,847	20,069	849,210

r Revised.
[1] Includes metal in depositories of the New York Mercantile Exchange; on December 31, 1975, this comprised 137,000 ounces of platinum and 10,300 ounces of palladium.

PRICES

The producers' price for platinum started the year at $190 per troy ounce and was lowered to $170 in February and again to $155 in April; raised to $170 in August, and was reduced again to $155 in October. Producers' palladium began the year at $150 per troy ounce, but was reduced to $120 in February, to $80 in June, and to $50 in October. Producers' rhodium and iridium prices held at $350 and $500 per troy ounce, respectively, during the first 9 months of the year, and then were reduced to $300 and $400, respectively, in October. Osmium and ruthenium prices remained unchanged at $200 and $60 per troy ounce, respectively.

Dealers' prices for rhodium and iridium began the year above producers' prices, but lost ground quickly in January and were well below producers' prices thereafter. Dealers' prices of the other four metals were below producers' prices all year. Average prices for the year, calculated at the low ends of the ranges of weekly averages published by Metals Week, follow:

	Producer (per troy ounce)	Dealer (per troy ounce)
Platinum	$164.23	$150.40
Palladium	93.46	66.48
Iridium	476.92	394.85
Osmium	200.00	136.09
Rhodium	338.46	278.34
Ruthenium	60.00	45.15

FOREIGN TRADE

Exports of unwrought and semimanufactured platinum-group metals decreased 21% in 1975 compared with 1974, to 660,000 ounces, of which nearly half was platinum. The exports were valued at $88 million. Of the exports, 26% went to Japan, 21% to West Germany, 15% to the United Kingdom, and the remainder to 45 other countries.

Imports fell 44% in 1975, to 1.8 million ounces, and value dropped 46%, to $273 million. Of total imports, 56% was platinum and 36% was palladium. Compared with 1974 levels, and including estimates of metal in composite import classes, platinum imports decreased 32%, while palladium imports fell 57%. Nearly half of total imports came directly from the Republic of South Africa, and a substantial part of the 20% of imports that came from the United Kingdom originated in South Africa. Only 18% of total imports came from the U.S.S.R., a reflection of the sharp drop in palladium imports. Imports of each metal were estimated as follows:

	Thousand troy ounces
Platinum	1,025
Palladium	655
Iridium	23
Osmium	3
Rhodium	94
Ruthenium	20
Total	1,820

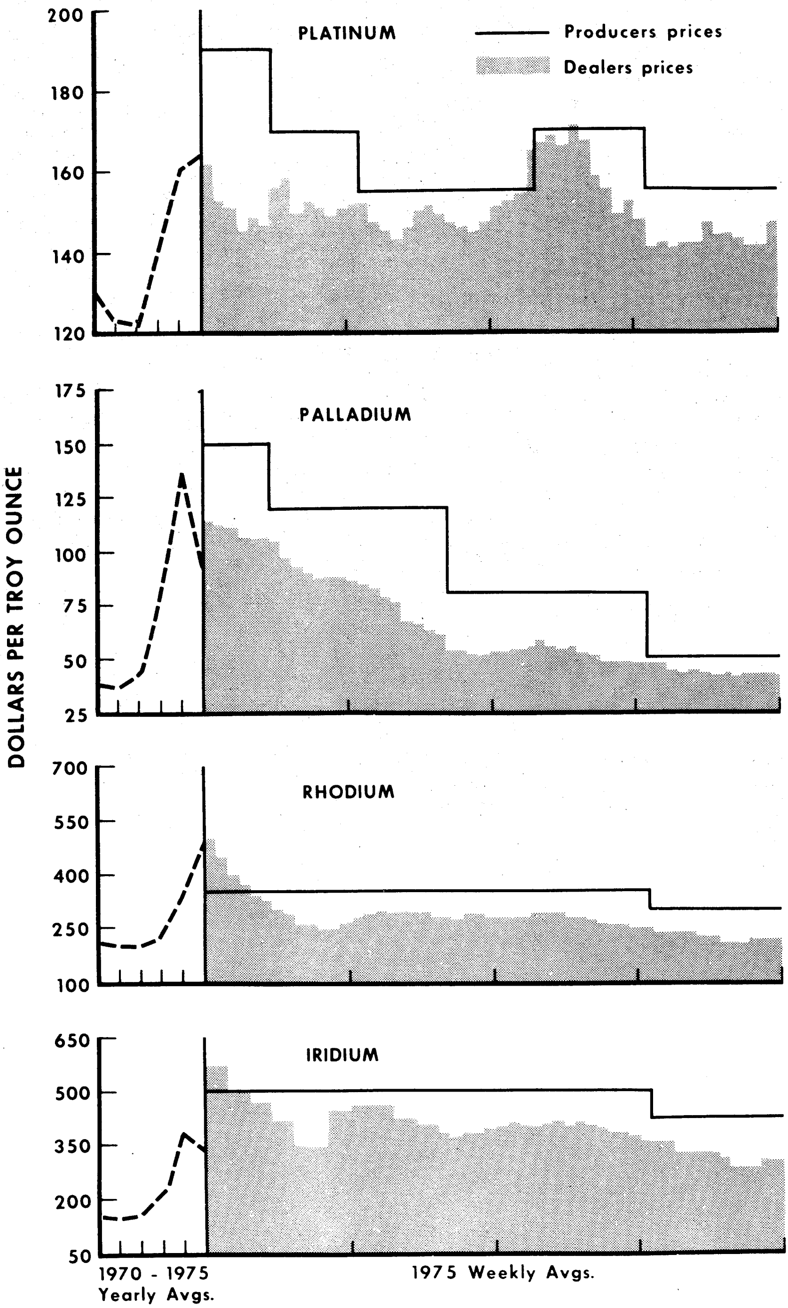

Figure 2.—Prices of four platinum-group metals.

Table 6.—U.S. exports of platinum-group metals, by country

Year and destination	Platinum-group metals: Ores and concentrates: Quantity (troy ounces)	Platinum-group metals: Ores and concentrates: Value (thousands)	Platinum-group metals: Waste, scrap, and sweepings: Quantity (troy ounces)	Platinum-group metals: Waste, scrap, and sweepings: Value (thousands)	Platinum, unworked or partly worked: Not rolled: Quantity (troy ounces)	Platinum, unworked or partly worked: Not rolled: Value (thousands)	Platinum, unworked or partly worked: Rolled: Quantity (troy ounces)	Platinum, unworked or partly worked: Rolled: Value (thousands)	Platinum-group metals, except platinum, unworked or partly worked: Not rolled: Quantity (troy ounces)	Platinum-group metals, except platinum, unworked or partly worked: Not rolled: Value (thousands)	Platinum-group metals, except platinum, unworked or partly worked: Rolled: Quantity (troy ounces)	Platinum-group metals, except platinum, unworked or partly worked: Rolled: Value (thousands)	Total: Quantity (troy ounces)	Total: Value (thousands)
1974:														
Belgium-Luxembourg	80	$16	49,620	$6,650	140	$41	--	--	24	$3	--	--	49,864	$6,710
Canada	611	71	--	--	1,847	278	1,922	$365	25,764	3,186	522	$30	30,666	3,930
France	--	--	--	--	137	30	7	2	6,975	701	2,144	264	9,263	997
Germany, West	38,457	2,067	21,916	2,368	33,101	7,195	--	--	79,473	9,889	8,606	1,194	181,553	22,713
Israel	--	--	--	--	--	--	--	--	72	6	12,927	286	12,999	292
Japan	--	--	--	--	193,251	35,869	10,586	1,940	39,466	5,540	4,129	720	247,432	44,069
Netherlands	600	84	3,359	433	11,183	2,019	4	1	9,004	1,619	303	209	24,453	4,365
South Africa, Republic of	--	--	1,300	237	100	20	20	6	23,793	4,125	--	--	25,213	4,388
Switzerland	48	34	16	1	9,066	1,837	--	--	84,130	6,368	1,793	246	95,053	8,486
Taiwan	--	--	--	--	20	4	--	--	11,107	406	140	18	11,267	428
United Kingdom	5,612	456	16,084	2,414	65,144	11,870	222	30	16,827	1,428	24	1	103,913	16,199
Other	93	54	432	12	9,022	1,642	494	96	32,550	2,878	1,487	162	44,078	4,844
Total	45,501	2,782	92,727	12,115	323,011	60,805	13,255	2,440	329,185	36,149	32,075	3,130	835,754	117,421
1975:														
Australia	--	--	--	--	1,112	188	13	4	655	40	--	--	1,780	232
Belgium-Luxembourg	--	--	30,889	2,847	920	184	--	--	991	144	12	1	38,812	3,176
Brazil	119	11	--	--	940	167	11	2	4,368	371	913	56	6,351	607
Canada	2,341	147	328	38	7,065	1,148	246	49	29,293	3,358	334	19	39,607	4,759
France	--	--	468	46	3,543	557	10	3	5,334	403	929	221	10,284	1,230
Germany, West	1,832	252	23,773	2,103	23,226	5,395	764	149	84,205	8,566	1,954	253	135,754	16,718
Israel	--	--	--	--	--	--	--	--	--	--	4,420	143	4,420	143
Italy	--	--	--	--	50	10	--	--	8,937	438	11,400	401	20,387	849
Japan	--	--	--	--	106,068	17,055	19,444	2,952	27,126	4,008	16,136	1,463	168,774	25,478
Netherlands	--	--	--	--	24,831	3,863	42	8	3,470	507	46	2	28,389	4,380
South Africa, Republic of	--	--	5,025	686	--	--	--	--	50,697	8,217	--	--	55,722	8,903
Switzerland	48	25	--	--	33,549	5,213	--	--	8,673	688	968	59	43,238	5,985
United Kingdom	3,371	293	23,265	2,353	59,428	9,990	10	4	10,229	702	1,353	63	97,656	13,405
Other	21	6	174	22	3,520	641	4	1	8,411	559	2,581	420	14,711	1,649
Total	7,732	734	83,922	8,095	264,252	44,411	20,544	3,172	242,389	28,001	41,046	3,101	659,885	87,514

Table 7.—U.S. imports for consumption of platinum-group metals, by country

Year and country	Unwrought (troy ounces)										
	Platinum grains and nuggets	Platinum sponge	Palladium	Iridium	Osmium	Osmiridium	Rhodium	Ruthenium	Unspecified combinations [1]	Platinum-group metals from precious metal ores	Sweepings, waste and scrap
1974	71,154	r 839,526	588,014	28,980	1,900	4,393	97,058	63,884	r 229,756	37,977	r 132,362
1975:											
Australia	--	--	1,124	12	--	--	--	--	--	--	5,340
Belgium-Luxembourg	--	18	18	--	--	--	--	--	--	--	25,513
Canada	--	1,564	10,614	152	105	--	787	16	665	--	42,460
Colombia	9,900	900	--	--	--	--	--	--	3,840	--	5,148
Costa Rica	--	510	--	--	--	--	--	--	--	--	1,342
Finland	--	--	--	--	--	--	61	--	285	--	2,565
France	--	--	1,979	--	--	--	--	--	--	--	265
Germany, West	76	1,477	9,869	510	--	--	3,028	62	--	--	310
Italy	--	289	--	--	--	--	--	--	--	35	13
Japan	340	5,673	2,283	507	--	--	12,831	--	19,298	--	--
Mexico	--	112	--	--	--	--	--	--	--	--	--
Netherlands	--	600	2,609	--	--	--	300	25	814	--	12,020
Norway	350	7,600	11,555	--	--	500	--	--	877	--	380
Panama	210	--	--	--	--	--	--	--	--	--	1,845
South Africa, Republic of	775	396,335	293,822	6,289	700	--	15,810	11,910	25,339	--	1,685
Sweden	--	--	--	--	--	--	--	--	--	--	5,031
Switzerland	602	800	4,447	--	--	--	100	25	21	--	--
U.S.S.R	--	--	19,369	1,349	16	--	37,806	--	174,843	--	--
United Kingdom	7,000	151,382	50,948	4,886	300	6,064	9,474	4,497	1,055	--	243
Yugoslavia	--	--	1,225	--	--	--	--	--	--	--	--
Other	--	206	--	714	--	--	--	--	--	--	12,363
Total	19,253	567,466	409,862	14,419	1,121	6,564	80,197	[2] 16,535	227,037	35	116,523

	Semimanufactured (troy ounces)								Platinum-group metals in materials not elsewhere specified (troy ounces)	Total	
	Platinum	Palladium	Iridium	Osmium	Osmiridium	Rhodium	Ruthenium	Unspecified combinations [1]		Quantity (troy ounces)	Value (thousands)
1974	199,355	750,078	366	--	25	1,549	400	7,030	197,509	r 3,251,311	r $504,619
1975:											
Australia	--	--	--	--	--	--	--	--	--	6,476	806
Belgium-Luxembourg	2,162	2,707	--	--	--	--	--	--	--	30,418	4,136
Canada	246	1,125	--	--	--	110	--	--	118	57,962	6,200
Colombia	1,800	--	--	--	--	--	--	--	--	21,588	2,988
Costa Rica	--	--	--	--	--	--	--	--	--	1,852	296
Finland	--	--	--	--	--	--	--	--	--	2,911	420
France	--	--	--	--	--	--	--	--	--	2,244	256
Germany, West	423	6,735	--	--	--	--	--	--	--	22,490	2,840
Italy	13	--	--	--	--	--	--	--	--	350	51
Japan	3,998	6,637	--	--	--	--	--	--	--	51,567	12,959
Mexico	--	--	--	--	--	--	--	--	--	12,132	1,723
Netherlands	1,652	--	--	--	--	--	--	--	--	6,000	768
Norway	1,279	--	--	--	--	--	--	--	13,596	36,137	4,466
Panama	--	--	--	--	--	--	--	--	--	2,055	174
South Africa, Republic of	15,056	659	--	--	--	--	--	4,503	64,198	837,081	115,554
Sweden	--	4,500	--	--	--	--	--	--	--	9,531	1,166
Switzerland	5,152	--	--	--	--	--	400	--	--	11,547	1,405
U.S.S.R	33,642	55,707	--	--	--	171	--	8,364	--	331,267	60,159
United Kingdom	31,207	66,170	941	--	--	1,551	8	--	26,442	362,168	55,022
Yugoslavia	--	--	--	--	--	--	--	--	--	1,225	48
Other	--	--	--	--	--	--	--	--	--	13,283	1,386
Total	96,630	144,240	941	--	--	1,832	408	12,867	104,354	1,820,284	272,823

r Revised.
[1] Contains not less than 90% platinum by weight.
[2] Estimated by Bureau of Mines.

Table 8.—Imports of platinum-group metals, in 1975, by source

(Percent of total imports)

Source	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
South Africa, Republic of	49	46	35	79	21	60	47
United Kingdom	21	18	31	10	13	22	20
U.S.S.R	19	13	14	--	45	9	18
Japan	3	2	3	--	14	1	3
Other	8	21	17	11	7	8	12

WORLD REVIEW

World mine production of the platinum-group metals in 1975 was 5.8 million ounces, the same level as in 1974. The Republic of South Africa and the U.S.S.R. accounted for 45% and 46%, respectively, of mined output, while nearly all of the remaining 9% came from Canada, except for a few thousand ounces from seven other countries, including the United States.

U.S. mine production was 18,920 ounces, compared with 12,657 ounces in 1974. Most of the output was byproduct metal from electrolytic copper refining; the remainder came from the placer deposit at Goodnews Bay, Alaska, where the platinum-group metals are mined as principal products.

Placer mining in Colombia yielded about 22,000 ounces. This level is substantially below the level attained in the early 1970's. All dredging was done by Mineros Colombianos, the Colombian company which in 1974 purchased two U.S.-owned mining companies—Cia. Minera Chocó Pacífico, S.A., and Pato Consolidated Gold Dredging, Ltd. Small quantities of platinum-group metals were obtained as byproducts of copper and nickel refining in Japan, Finland, the Philippines, and Australia.

Canada.—Production of platinum-group metals in Canada increased 12% to 430,000 ounces. The platinum-group metals were byproducts of nickel-copper mining in the Sudbury, Ontario, and Thompson, Manitoba, districts. The principal producers were International Nickel Co., Inc., and Falconbridge Nickel Mines, Ltd. Exploratory drilling continued at the platinum-group metals discovery at Lac des Iles, 50 miles northwest of Thunder Bay, Ontario. Texasgulf, Inc., which took an option on the property early in 1975, reported that possible reserves of about 22.5 million ounces were indicated by drilling. Grade in the mineralized zone ranged from 0.1 ounce for platinum-group metals per ton to more than 0.2 ounce per ton, with palladium being more abundant than platinum.[3]

South Africa, Republic of.—South African mine output of platinum-group metals in 1975 was 2.6 million ounces, a 7% reduction below the 1974 level. South Africa, in 1975, was the world's largest producer of platinum (63%), rhodium (59%), and ruthenium (48%), and may have been the largest producer of osmium as well. A very small quantity of osmiridium was recovered as a byproduct of gold mining, but essentially all of the platinum-group minerals were mined as the principal products from mines in the Merensky Reef, an extensive rock formation in Transvaal Province. The Reef alone contains more than half of the world's know resources of platinum-group metals, in an ore that grades about 0.2 ounce of platinum-group metals per ton, plus 0.15% copper-nickel. Estimated capacities and production of the four companies that mined platinum-group metals are as follows:

[3] Texasgulf, Inc. Third Quarter Report, 1975. Pp. 5–6.

Company	Estimated 1975 yearend capacity, platinum-group metals (thousand ounces)	Estimated 1975 production platinum-group metals (thousand ounces)
Rustenburg Platinum Mines Ltd	2,250	1,490
Impala Platinum Ltd	1,530	970
Western Platinum Ltd	150	130
Atok Platinum Mines, Pty., Ltd	40	30

In February, Rustenburg, in order to balance supply with the weakened demand for platinum in the western countries, began to cut its production by 25%, to a rate of about 1,450,000 ounces of platinum-group metals per year. It also slowed and changed its expansion plans.[4] At about the same time, Impala decided to hold its production at about 970,000 ounces per year and to substantially reduce its expenditures for expansion.[5]

Lonhro, Ltd., announced plans to build an extension to its refinery at Brakpan, featuring an ion exchange refining method developed by the National Institute for Metallurgy.[6]

U.S.S.R.—Production of platinum-group metals in the U.S.S.R. in 1975 was estimated at 2.6 million ounces, a 6% increase over the 1974 level. The U.S.S.R. was the world's largest producer of palladium (64%) and iridium (54%) in 1975. Most of the platinum-group metals were recovered as byproducts of nickel-copper mining in the Norilsk-Talnakh region of Northwestern Siberia, and from the Petsamo-Monchegorsk region of the Kola Peninsula. A small quantity was recovered, along with gold, from the old platinum placer deposits in the central Ural Mountains. Construction of the large nickel mining-metallurgical complex at Talnakh presumably progressed in 1975.

[4] Engineering and Mining Journal. This Month in Mining. V. 176, No. 5, April 1975, p. 178.
———. This Month in Mining. V. 177, No. 1, January 1976, p. 160.

[5] American Metal Market. Impala Cuts Back. V. 82, No. 34, Feb. 19, 1975, p. 2.

[6] Metal Bulletin. Western Platinum's Refinery. No. 5999, June 17, 1975, pp. 19–20.

Table 9.—Platinum-group metals: World production by country [1]

(Troy ounces)

Country	1973	1974	1975 p
Australia:			
Palladium, metal content, from nickel ore e	r 750	r 860	1,400
Platinum, metal content, from nickel ore e	r 225	r 260	420
Canada: Platinum-group metals from nickel ore	354,223	384,618	430,000
Colombia: Placer platinum	26,358	21,094	22,114
Ethiopia: Placer platinum	235	230	162
Finland: Platinum-group metals from copper ore e	725	650	600
Japan: [2]			
Palladium from nickel and copper ores	r 5,834	11,104	13,981
Platinum from nickel and copper ores	r 4,363	4,101	5,482
Philippines:			
Palladium from nickel-cobalt ore	r 4,180	2,315	836
Platinum from nickel-cobalt ore	r 2,476	1,350	579
South Africa, Republic of:			
Platinum-group metals from platinum ores e	2,360,000	2,832,000	2,620,000
Osmiridium from gold ores (sales) e	2,800	2,500	2,400
U.S.S.R.: Placer platinum and platinum-group metals recovered from nickel-copper ores e	2,450,000	2,500,000	2,650,000
United States: Placer platinum and platinum-group metals from gold and copper ores	19,980	12,657	18,920
Total [3]	r 5,232,149	5,773,739	5,766,894

e Estimate. p Preliminary. r Revised.

[1] Excludes metal refined in Norway and the United Kingdom derived from Canadian and South African ores.

[2] Japanese figures exclude metal recovered from Philippine ore.

[3] Total excludes metal refined in West Germany and which is believed to be derived from imported ores. Production was as follows: 1974—3,340 ounces; 1974—4,115 ounces; 1975—3,601 ounces.

TECHNOLOGY

Automotive emissions control catalysts, in which platinum or platinum-palladium were the active metals, were used on most of the new cars sold in the United States in 1975. By most accounts, they performed reliably and were free of some of the difficulties that had been feared, such as catastrophic overheating or rapid poisoning. In October, General Motors Corp. (GM) and the Environmental Protection Agency (EPA) conducted a joint study involving several hundred vehicles, driven simultaneonsly on the GM test track, to determine whether sulfate emissions generated by the catalysts could reach hazardous levels in adverse traffic density-weather conditions. The test showed that the likelihood of hazardous accumulation was considerably less than had been thought, even when all the vehicles were equipped with catalytic converters.[7] It was demonstrated in another study that the position of the converter in the exhaust train and its operating temperature both have an important influence on the degree of lead poisoning of the catalyst, especially when lead scavengers, such as ethylene dibromide, are used.[8] In another automotive development, a new platinum- or ruthenium-containing catalyst said to be compatible with leaded gasoline was reported.[9]

A Monsanto Chemical Co. plant came onstream using a new rhodium-based homogeneous catalyst for the synthesis of acetic acid from methanol and carbon monoxide.[10] Another rhodium-based catalyst for hydroformylation, or oxo, reactions was developed and will be used in three new plants being built by Union Carbide Corp.[11]

Bureau of Mines scientists in 1975 worked on the formation of platinum metal shapes by chemical vapor deposition, and the formation of heavy platinum coatings by electrodeposition from molten salt baths. Industry reported that coatings up to 0.006 inch (150 micrometers) thick can be plated from molten cyanide baths.[12]

The conventional method for metallization of glass involves dipping in an acidic stannous chloride solution, then in an acidic palladium chloride solution, and finally in an electroless nickel plating bath. Tin ions are absorbed on the glass surface and then displaced galvanically by palladium ions, which nucleate nickel deposition. It was reported that a more strongly adherent nickel film could be formed by electroless plating onto palladium ions which had been injected into the glass surface from a glow discharge.[13] It was also reported that stress-free, adherent films of platinum could be deposited on gallium arsenide crystals, used in certain high-power microwave devices, by radiofrequency sputtering.[14]

Electrically conductive thick films, made by screen printing a paste of silver-palladium alloy powder mixed with glass onto a ceramic substrate and then firing the assembly, are widely used in hybrid microelectronic circuits. Leadout wires are readily soldered to the silver-palladium-glass conductors, but prolonged use at operating temperatures leads to drastic weakening of the attachments and thus to circuit failure. A study of the problem led to a new paste formulation and manufacturing method which resulted in substantial improvement in adherence of aged films.[15] Also, a new thick-film platinum resistance thermometer was developed that is mechanically stronger and cheaper than conventional resistance thermometers.

A process for manufacturing submicrometer-thick palladium flakes was described. These are potentially useful for the solid storage of hydrogen.[16]

[7] Chemical and Engineering News. Auto Sulfate Hazard Less Than Predicted. V. 54, No. 20, May 10, 1976, pp. 4–5.
[8] Platinum Metals Review. Lead Poisoning of Automobile Emission Control Catalysts. V. 19, No. 4, October 1975, pp. 141–145.
[9] Chemical Week. Maybe Gasoline Won't Have To Get the Lead Out. V. 117, No. 11, Sept. 10, 1975, pp. 39–42.
[10] Roth, J. F. The Production of Acetic Acid. Platinum Metals Rev., v. 19, No. 1, January 1975, pp. 12–14.
[11] Platinum Metals Review. New Technology for Industrial Hydroformylation. V. 19, No. 3, July 1975, pp. 93–95.
[12] Platinum Metals Review. Heavy Platinum Plating From a Molten Salt Bath. V. 19, No. 1, January 1975, p. 15.
[13] Ceramic Bulletin. Metallization of Glass Using Ion Injection. V. 55, No. 5, May 1976, pp 530–532.
[14] Thin Solid Films. V. 23, 1974, pp. 323–326.
[15] Platinum Metals Review. High Tensile Strength Thick-Film Silver-Palladium Metallisations. V. 19, No. 4, October 1975, pp. 146–153.
[16] International Journal of Powder Metallurgy and Powder Technology. V. 2, No. 2, February 1975, pp. 97–100.

Potash

By Richard H. Singleton [1]

Domestic potash production dropped 2% to 2.5 million short tons of K_2O equivalent in 1975; this was the third successive year of slight decline. Total value increased 40% over that of 1974. Apparent consumption decreased 17% to 5.1 million tons of K_2O because of reduced demand for fertilizer at the farm level. Domestic producers stockpiled 16% of their production and their total stockpiles nearly tripled to 0.6 million tons of K_2O at yearend. Exports for fertilizer use decreased 2% remaining near 0.8 million tons of K_2O. Imports for fertilizer use, approximately 95% from Canada, decreased 14% to 3.7 million tons of K_2O but still accounted for 64% of domestic potash deliveries.

Disagreement continued in the Canadian Province of Saskatchewan between the provincial government and private industry regarding production and marketing of potash. The industry filed suit on the constitutionality of the reserves tax. Legislaion was passed by the provincial government in January 1976, enabling them to acquire 50% or more of the potash industry in the province. Although Canadian production of potash, all in Saskatchewan, remained the same, at 6.0 million tons of K_2O, producers' inventories increased by a factor of 8 to 1.0 million tons of K_2O at yearend.

Potash production as well as mine and plant capacity continued to increase in the U.S.S.R. Production in the centrally planned economy countries reportedly increased 4% to 12.4 million tons of K_2O. Production in Western Europe decreased 10% to 5.4 million tons of K_2O. Jordan announced plans for construction of a large plant to recover potash from Dead Sea brines. An extensive potash deposit was discovered in Laos. Full production at the large, new mine in Yorkshire, England, was delayed because of technical difficulties. Exploitation of potash deposits in Brazil was postponed because of the presence of petroleum activities in the same area.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient statistics on potassium salts
(Thousand short tons and thousand dollars)

Item	1971	1972	1973	1974	1975
United States:					
Production	4,543	4,738	4,684	4,716	4,576
K_2O equivalent	2,587	2,659	2,603	2,552	2,501
Value	$100,527	$106,680	$112,613	r $159,148	$223,098
Sales by producers	4,578	4,653	5,174	r 4,708	3,819
K_2O equivalent	2,592	2,618	2,865	2,545	2,094
Value at plant	$102,099	$104,680	$123,738	r $158,607	$187,857
Average value per ton	$22.30	$22.50	$23.92	r $33.69	$49.19
Imports for consumption [1]	4,672	4,979	6,046	7,245	6,271
K_2O equivalent	2,766	2,961	3,587	4,326	3,736
Value	$111,844	$119,666	$145,693	$236,747	$267,248
Deliveries [2]	9,250	9,632	11,220	11,953	10,090
K_2O equivalent	5,358	5,579	6,452	6,871	5,830
Exports [1]	1,033	1,353	1,579	1,415	1,419
K_2O equivalent	564	764	889	787	769
Value	$35,323	$45,858	$57,997	$66,175	$92,701
Apparent consumption [3]	8,217	8,279	9,641	r 10,538	8,671
K_2O equivalent	4,794	4,815	5,563	6,084	5,061
World production, marketable:					
K_2O equivalent	r 20,553	r 20,841	r 23,855	r 26,432	27,423

r Revised.
[1] Excludes potassium chemicals and mixed fertilizers.
[2] Measured by sales plus imports.
[3] Measured by deliveries minus exports.

DOMESTIC PRODUCTION

Production of marketable potash salts, in terms of K_2O content, declined 2% in 1975 compared with 1974 output. The value of production increased 40%, however, in a continuation of last year's price rise. Costs of production at potash mines were affected by the general rise in price levels, particularly for fuel, power, and explosives. Eighty percent of U.S. production was as potassium chloride and 10% was as potassium sulfate.

Potash sales by domestic producers equaled 36% of deliveries in 1975 compared with 37% in 1974. The remaining 64% of 1975 deliveries were met by imports.

In New Mexico, source of 83% of U.S. production in 1975, eight underground mines were operated near Carlsbad by AMAX Chemical Corp., Duval Corp., International Minerals & Chemical Corp., Kerr-McGee Chemical Corp., Mississippi Chemical Corp., National Potash Co., and Potash Co. of America.

The following three companies produced potash in Utah: Texasgulf, Inc., working an underground mine near Moab by solution mining; Great Salt Lake Minerals & Chemicals Corp., producing potassium sulfate from brines of the Great Salt Lake; and Kaiser Aluminum & Chemical Corp., treating natural surface brines near Wendover.

In California, potash continued to be produced from Searles Lake brines by the Kerr-McGee Chemical Corp.

Table 2.—Marketable potassium salts produced and sold or used in the United States, in 1975, by product

(Thousand short tons and thousand dollars)

Item	Production			Sold or used		
	Gross weight	K_2O equivalent	Value [1]	Gross weight	K_2O equivalent	Value
January–June 1975:						
Muriate of potash, 60% K_2O minimum:						
Standard	888	539	41,024	664	404	30,797
Coarse	415	253	18,920	353	215	16,135
Granular	355	216	15,883	289	175	12,772
Potassium sulfate	266	139	22,576	223	116	18,953
Other potassium salts [2]	492	152	18,239	406	128	15,215
Total [3]	2,416	1,298	116,643	1,935	1,038	93,872
July–December 1975:						
Muriate of potash, 60% K_2O minimum:						
Standard	891	541	41,319	697	425	32,713
Coarse	342	208	15,856	332	203	15,467
Granular	408	249	18,584	400	244	18,280
Potassium sulfate	197	101	18,280	176	91	16,528
Other potassium salts [2]	324	104	12,418	279	93	10,998
Total [3]	2,161	1,202	106,456	1,884	1,056	93,985
Grand total [3]	4,576	2,501	223,098	3,819	2,094	187,857

[1] Derived from reported value of "Sold or used."
[2] Includes chemical and soluble muriates, manure salts and potassium-magnesium sulfate.
[3] Data may not add to totals shown because of independent rounding.

Table 3.—Production and sales of potassium salts in New Mexico in 1974–75

(Thousand short tons and thousand dollars)

Period	Crude salts [1]		Marketable potassium salts					
	Mine production		Production			Sold or used		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value [2]	Gross weight	K_2O equivalent	Value
1974:								
January–June	8,442	1,305	1,958	1,042	56,029	2,022	1,075	57,827
July–December	8,764	1,361	1,991	1,060	72,559	1,863	986	68,196
Total	17,206	2,666	3,949	2,102	128,588	3,885	2,061	126,023
1975:								
January–June	9,156	1,402	2,037	1,079	93,661	1,603	846	73,987
July–December	8,653	1,298	1,817	1,002	86,263	1,618	903	76,634
Total	17,809	2,700	3,854	2,081	179,924	3,221	1,749	[3] 150,622

[1] Sylvite and langbeinite.
[2] Derived from reported value of "Sold or used."
[3] Data do not add to total shown bceause of independent rounding.

The potash (K_2O) content of ores mined in New Mexico declined to 15.2% in 1975 from 15.5% in 1974. These ores had contained 18.0% K_2O in 1964.

In 1975 Mississippi Chemical Corp. opened a mine previously owned by Teledyne. It had been closed in 1973 and purchased from Teledyne in 1974. Previous plans to construct a new processing facility were abandoned; instead, plans were announced in May to modernize the old facility including installation of new flotation cells. Estimated planned output of the modernized facility was 170,000 tons of K_2O equivalent per year.

Duval Corp. increased muriate of potash production capacity at Carlsbad in late 1975 through acquisition and equipment of a new mine.

A planned expansion by International Minerals & Chemical Corp. at Carlsbad, which had begun in 1974, was terminated in 1975.

A sweeping investigation of the fertilizer industry was launched early in 1975 by a Federal grand jury in Chicago, Ill., to determine whether there had been any price fixing or other antitrust violations in either domestic or foreign operations.

A preliminary report[2] dealing with the present and projected environmental impact of potash mining and beneficiation on public lands in New Mexico was issued by the Bureau of Land Management. Public meetings were scheduled for early 1976 for discussions on these matters with an intention of subsequently issuing a final report.

Exploratory drillings were made 30 miles east of Carlsbad, N. Mex., in behalf of the Energy Research and Development Administration (ERDA) to investigate the salt beds in that area as a potential underground site for disposal of radioactive waste products. It was estimated that use of this contemplated storage site would effectively eliminate about 8% of the potash resources in New Mexico.[3]

[2] Bureau of Land Management, New Mexico State Office, Albuquerque, N. Mex. Potash Leasing in Southeastern New Mexico, Preliminary Regional Environmental Analysis Record. October 1975, 882 pp.

[3] U.S. Geological Survey. Potash Resources in Part of Los Medanos Area of Eddy and Lea Counties, New Mexico. Open File Rept. 75–407, 1975, 37 pp.

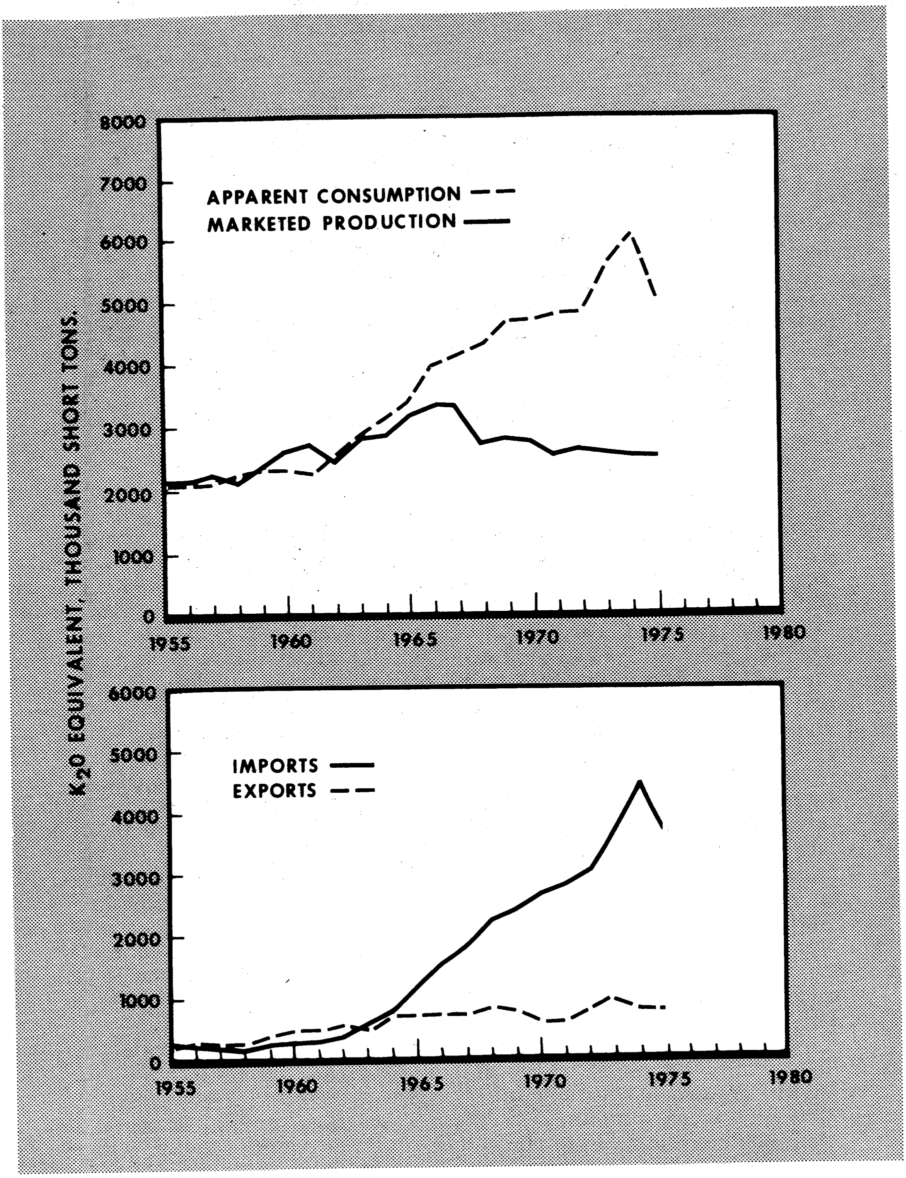

Figure 1.—Marketable production, apparent consumption, exports and imports of potassium salts measured in K_2O equivalent.

CONSUMPTION AND USES

Apparent domestic consumption of potash decreased 17% to 5.1 million tons of K_2O; approximately 94% of this was used in the fertilizer industry and the balance in chemicals manufacture. The north-central States of Illinois, Indiana, Iowa, Minnesota, and Ohio purchased 47% of all agricultural potash. Leading consumers of chemical potash were New York (22%), Alabama (16%), Illinois (14%), and Ohio (13%). Ninety-two percent of domestic raw potash was consumed as potassium chloride and 3% was consumed as potassium sulfate.

Table 4.—Sales of potash salts in 1975, by State of destination
(Short tons K_2O equivalent)

Destination	Agricultural potash	Chemical potash	Destination	Agricultural potash	Chemical potash
Alabama	76,677	43,490	Nebraska	44,218	165
Arizona	745	269	Nevada	--	184
Arkansas	31,421	869	New Hampshire	291	--
California	53,284	5,591	New Jersey	11,585	954
Colorado	8,510	1,223	New Mexico	7,159	281
Connecticut	2,666	134	New York	61,201	57,944
Delaware	19,669	23,460	North Carolina	122,181	730
Florida	189,166	786	North Dakota	16,118	14
Georgia	193,064	643	Ohio	330,428	33,841
Hawaii	20,933	--	Oklahoma	16,570	369
Idaho	11,466	--	Oregon	14,082	1,114
Illinois	609,721	38,612	Pennsylvania	55,732	3,275
Indiana	397,920	4,943	Rhode Island	1,829	251
Iowa	441,323	341	South Carolina	69,517	536
Kansas	30,245	1,367	South Dakota	10,815	--
Kentucky	93,907	15,196	Tennessee	83,623	90
Louisiana	40,033	439	Texas	196,399	14,704
Maine	9,891	106	Utah	1,968	137
Maryland	45,353	1,528	Vermont	5,396	--
Massachusetts	1,909	636	Virginia	75,878	1,037
Michigan	146,994	1,779	Washington	29,005	2,927
Minnesota	355,293	801	West Virginia	2,230	131
Mississippi	175,743	3,020	Wisconsin	262,737	223
Missouri	179,112	2,197	Wyoming	1,462	1,275
Montana	3,909	472			
			Total	[1]4,559,378	[2]268,084

[1] Distribution of K_2O—1,065,094 tons as standard muriate; 1,810,745 tons as coarse muriate; 1,186,748 tons as granular muriate; 298,325 tons as soluble muriate; and 198,466 tons as sulfates.
[2] Distribution of K_2O—197,284 tons as muriate; 67,522 tons as soluble muriate; and 3,278 tons as sulfates.
Source: Potash Institute of North America, Atlanta, Georgia.

STOCKS

Domestic producers stockpiled 16% of their production in 1975 because of reduced demand, mainly because of resistance to higher prices on the farm level; similar stockpiling in 1974 had been less than 1%. Canadian producers' stocks at both onsite and offsite locations increased considerably during 1975—from 132,000 tons of K_2O at yearend 1974, to 1,091,000 tons at yearend 1975.

Table 5.—Yearend stocks of marketable potassium salts in the United States
(Thousand short tons)

Year	Number of producers	Stocks, Dec. 31	
		Gross weight	K_2O equivalent
1971	11	796	428
1972	11	878	468
1973	11	388	206
1974	10	394	211
1975	11	1,152	619

PRICES

Prices continued an upward trend during 1975, although not as sharply as during 1974 when potassium muriate prices increased by approximately 50%. Canadian prices, f.o.b. mine, for muriate of potash remained at a few dollars per ton less than U.S. prices.

Table 6.—Bulk prices for potash in 1975 [1]
(U.S. cents per unit K_2O)

	Jan. 1	Jan. 12	April 1	June 1	July 1	Sept. 1
Muriate, 60% K_2O minimum:						
Standard	65	74	74	65	70	75
Soluble 62% to 63% K_2O	71	80	80	68	75	80
Coarse	69	78	78	68	73	78
Granular	71	80	80	70	75	80
Sulfate of potash, 50% K_2O minimum:						
Standard	140	160	160	160	175	175
Granular	160	180	180	180	195	195

[1] Carlots, f.o.b. cars, Carlsbad, N. Mex.

Source: Potash Co. of America, Division of Ideal Basic Industries, Inc.

FOREIGN TRADE

About 14% of U.S. potash deliveries were exported in 1975 as fertilizer, 80% of which was muriate of potash and the balance mainly sulfate; total tonnage was not significantly different from that exported in 1974. In addition about 1% was exported as chemicals; this represented nearly triple that exported as chemicals in 1974 with most of the increase going to Brazil.

Potash imports decreased 14% but still accounted for 64% of domestic potash deliveries; approximately 95% of these imports were from Canada. Muriate of potash comprised 98% of the imports. The second-place supplier, Israel, provided a little over 2% of U.S. imports in 1975. Imports of potash from the Congo began, and it became the third-place supplier providing about 1% of U.S. imports in 1975.

Table 7.—U.S. exports of potash materials, by use

Materials	Approximate equivalent as potash (K_2O) percent	1974 Quantity (short tons)	1974 Approximate equivalent as potash (K_2O) Short tons	1974 Approximate equivalent as potash (K_2O) Percent of total	1974 Value (thousands)	1975 Quantity (short tons)	1975 Approximate equivalent as potash (K_2O) Short tons	1975 Approximate equivalent as potash (K_2O) Percent of total	1975 Value (thousands)
Used chiefly as fertilizers:									
Potassium chloride all grades	60	1,111,203	666,722	83.1	$50,058	1,020,166	612,100	75.9	$64,904
Potassic chemical fertilizer n.e.c	40	297,040	118,816	14.8	15,780	384,152	153,661	19.1	26,837
Natural potassic salt fertilizers, crude	20	6,355	1,271	.2	337	14,999	3,000	.4	[1] 960
Total	XX	1,414,598	786,809	98.1	66,175	1,419,317	768,761	95.4	[1] 92,701
Used chiefly in chemical industries:									
Potassium hydroxide	80	6,505	5,240	.6	1,603	9,236	7,389	.9	2,095
Potassium peroxide	83	655	544	.1	36	3	2	--	1
Potassium compounds, n.e.c	31	31,130	9,650	1.2	13,073	95,258	29,530	3.7	16,853
Total	XX	38,290	15,398	1.9	14,712	104,497	36,921	4.6	18,949
Grand total	XX	1,452,888	802,207	100.0	80,887	1,523,814	805,682	100.0	[1] 111,650

XX Not applicable.
[1] Adjusted by the Bureau of Mines.

Table 8.—U.S. exports of potash materials, by country

Destination	Fertilizer: Chloride quantity (short tons)		Fertilizer: Chemical fertilizer n.e.c. quantity (short tons)		Fertilizer: Total				Chemical: Hydroxide (caustic) quantity (short tons)		Chemical: Other n.e.c. quantity (short tons)		Chemical: Total			
					1974		1975						1974		1975	
	1974	1975	1974	1975	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	1974	1975	1974	1975	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	2,205	1,653	4,742	1,802	6,947	$340	3,455	$389	6	--	322	182	328	$205	182	$136
Australia	162,756	73,514	796	1,608	[1]167,274	[1]6,873	75,122	3,731	66	--	928	3,547	994	560	3,547	571
Belgium-Luxembourg	--	--	--	--	--	--	--	--	105	--	282	11,279	387	271	11,279	796
Brazil	208,535	343,715	15,462	130,925	233,997	10,218	474,640	29,672	1,140	286	1,110	46,249	2,250	942	46,535	3,944
Canada	4,804	5,618	88,334	55,349	[1]93,682	[1]4,587	[1]71,493	[1]3,938	3,121	7,363	9,831	7,953	12,952	4,006	15,316	5,079
Chile	21	--	--	--	21	1	--	--	--	--	50	54	50	17	54	55
China, People's Republic of	--	--	--	--	--	--	--	--	--	--	--	434	--	--	434	222
Colombia	42,160	7,385	22,388	15,168	64,548	3,467	[1]26,929	[1]2,233	64	87	6,123	4,974	6,187	410	5,061	335
Costa Rica	26,318	23,820	7,651	6,502	33,969	1,700	30,322	2,538	1	1	17	22	18	29	23	10
Dominican Republic	22,135	11,778	1,674	1,260	[1]23,953	[1]1,359	13,038	1,290	--	1	38	42	38	21	43	32
Ecuador	2,877	--	--	--	2,877	141	--	--	55	--	39	5	94	57	5	9
El Salvador	3,082	5,511	--	7,850	3,082	127	13,361	1,046	12	--	38	4	50	27	4	7
Finland	17,085	--	--	44	17,085	500	44	2	--	--	--	5	--	--	5	3
France	--	--	--	--	--	--	--	--	--	--	154	27	154	100	27	101
Germany, West	--	5,724	--	--	--	--	5,724	338	5	--	4,017	4,667	4,022	1,940	4,667	2,832
Guatemala	--	--	--	--	--	--	--	--	49	17	7	5	56	22	22	13
Guyana	--	1,302	--	277	--	--	1,579	211	--	--	(2)	5	(2)	1	5	3
Honduras	--	451	3,376	45	3,376	260	496	66	--	--	250	10	250	22	10	15
India	22	--	--	--	22	1	--	--	--	--	151	53	151	41	53	14
Indonesia	45	--	--	--	45	15	--	--	5	1	929	95	934	629	96	58
Ireland	40,626	10,098	--	--	40,626	1,783	10,098	509	--	--	7	1	7	5	1	2
Israel	87	--	--	--	87	3	--	--	63	316	14	17	77	33	333	102
Italy	--	79	--	--	[1]40	[1]1	[1]119	[1]4	--	--	69	118	69	33	118	84
Jamaica	10,400	14,050	--	--	10,400	766	14,050	1,126	24	11	26	27	50	34	38	36
Japan	109,409	92,176	81,526	79,930	[1]191,144	[1]9,628	172,106	11,397	55	--	1,153	178	1,208	1,468	178	504
Korea, Republic of	--	3,300	21,842	29,070	21,842	1,073	32,370	2,772	194	--	128	54	[3]329	[3]158	54	32
Malaysia	--	15,899	--	--	--	--	15,899	1,659	--	--	34	15	34	20	15	15
Mexico	77,005	135,936	27,079	23,550	104,084	3,185	[1]159,524	[1]9,442	611	239	2,025	1,458	[3]2,639	[3]1,224	[3]1,699	[3]830
Netherlands	6	--	--	--	6	1	--	--	45	60	292	172	337	240	232	160
Netherlands Antilles	76	--	--	--	76	2	--	--	111	269	(2)	--	111	48	269	118
New Zealand	217,366	121,397	--	--	217,366	8,571	121,397	8,366	--	19	102	32	102	74	51	30
Nicaragua	--	728	729	41	[1]801	[1]133	769	116	--	--	3	4	3	9	4	10
Panama	20	2,600	707	54	727	54	2,654	340	2	--	42	33	44	23	33	24
Peru	10,967	59	2,502	--	13,469	865	59	4	10	9	87	154	97	65	163	184
Philippines	74,084	33,073	48	1,515	74,132	4,031	34,588	1,961	4	3	230	67	234	170	70	52
Singapore	--	268	10,034	7,898	10,034	773	8,166	474	4	1	72	26	76	33	27	46
South Africa, Republic of	150	54	--	--	150	5	54	2	110	--	206	5,845	316	168	5,845	545

Spain	--	3,638	--	--	--	--	3,638	147	--	--	100	13	100	58	13	8
Sweden	1,692	594	--	--	1,692	111	[1]611	[1]71	--	--	38	59	38	30	59	51
Taiwan	26,911	98,575	--	--	26,911	1,751	98,575	7,138	--	--	549	23	549	306	23	16
Thailand	--	5,511	--	15,321	--	--	20,832	1,286	33	--	2	([2])	35	1	([2])	1
U.S.S.R	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1	3
United Kingdom	--	44	--	--	[1]66	[1]2	44	1	115	42	660	6,657	775	423	6,699	748
Uruguay	--	--	7,983	5,407	7,983	363	5,407	297	--	--	--	89	--	--	89	69
Venezuela	34,254	406	--	--	[1]34,277	[1]2,372	406	13	396	341	444	404	[3]1,485	[3]368	745	457
Vietnam, South	4,081	927	--	--	4,081	257	927	45	--	--	110	17	110	20	17	5
Other	12,024	283	167	536	[1]13,726	[1]856	[1]821	[1,4]77	99	170	451	182	550	401	[3]353	[3]582
Total	1,111,203	1,020,166	297,040	384,152	[1]1,414,598	[1]66,175	[1]1,419,317	[1,4]92,701	6,505	9,236	31,130	95,258	[3]38,290	[3]14,712	[3]104,497	[3]18,949

[1] Includes crude natural potassic salt fertilizer—1974: Australia, 3,722 tons ($238,195); Poland 1,089 tons ($36,500); Canada, 544 tons ($26,872); Hong Kong, 361 tons ($13,999); Japan, 209 tons ($6,981); the Dominican Republic, 144 tons ($4,814); Nicaragua, 72 tons ($2,400); Saudi Arabia, 69 tons ($2,319); the United Kingdom, 66 tons ($2,226); Italy, 40 tons ($1,324); Venezuela, 23 tons ($785); Switzerland, 16 tons ($530). 1975: Canada, 10,526 tons ($588,878); Colombia, 4,376 tons ($366,521); Switzerland, 2 tons ($2,400); Mexico, 38 tons ($1,275); Italy, 40 tons ($1,340); Sweden, 17 tons ($564).

[2] Less than ½ unit.

[3] Includes potassium peroxide—1974: Venezuela, 645 tons ($25,488); the Republic of Korea, 7 tons ($6,500); Mexico, 3 tons ($3,518). 1975: Mexico, 2 tons ($700); Bermuda, 1 ton ($1,284).

[4] Adjusted by the Bureau of Mines.

Table 9.—U.S. imports for consumption of potash materials, by use

Materials	Approximate equivalent as potash (K_2O) percent	1974 Quantity (short tons)	1974 Approximate equivalent as potash (K_2O) Short tons	1974 Approximate equivalent as potash (K_2O) Percent of total	1974 Value (thousands)	1975 Quantity (short tons)	1975 Approximate equivalent as potash (K_2O) Short tons	1975 Approximate equivalent as potash (K_2O) Percent of total	1975 Value (thousands)
Used chiefly as fertilizers:									
Muriate (chloride)	60	7,145,585	4,287,351	98.9	$228,623	6,131,931	3,679,159	98.2	$248,329
Potassium nitrate, crude	40	14,109	5,644	.1	1,797	35,791	14,316	.4	7,016
Potassium sodium nitrate mixtures, crude	14	25,934	3,631	.1	2,489	24,947	3,493	.1	4,388
Potassium sulfate, crude	50	57,882	28,941	.7	3,734	76,968	38,484	1.0	7,393
Other potash fertilizer material	6	1,419	851	--	104	1,839	110	--	122
Total	XX	7,244,929	4,326,418	99.8	236,747	6,271,476	3,735,562	99.7	267,248
Used chiefly in chemical industries:									
Bicarbonate	46	1,409	648		400	1,671	769		464
Bitartrate:									
Argols	20	6	1		7	--	--		--
Cream of tartar	25	1,417	354		2,550	503	126		751
Carbonate	61	2,163	1,319		470	2,239	1,366		598
Caustic	80	1,871	1,497		752	7,171	5,737		2,721
Chlorate and perchlorate	36	437	157	.2	125	224	81	.3	93
Cyanide	70	1,151	806		717	297	208		244
Ferricyanide	42	840	353		999	444	186		625
Ferrocyanide	44	1,341	590		897	769	338		679
Nitrate	50	318	159		31	765	383		197
Rochelle salts	22	556	122		712	190	42		254
Sorbate [1]	21	NA	NA		NA	1,618	421		4,626
All other	31	8,784	2,723		11,675	4,962	1,538		6,772
Total	XX	20,293	8,729	.2	19,335	20,853	11,195	.3	18,024
Grand total	XX	7,265,222	4,335,147	100.0	256,082	6,292,329	3,746,757	100.0	285,272

NA Not available. XX Not applicable.
[1] Class established Jan. 1, 1975.

Table 10.—U.S. imports for consumption of potash materials, by country
(Short tons)

Year and country	Bitartrate cream of tartar	Caustic (hydroxide)	Chlorate and perchlorate	Cyanide	Muriate (chloride)	Potassium nitrate, crude	Potassium sodium nitrate mixtures, crude	Potassium nitrate (saltpeter), refined	Potassium sulfate	All others	Total: Quantity	Total: Value (thousands)
1974:												
Argentina	148	--	--	--	--	--	--	--	--	--	148	$139
Belgium-Luxembourg	--	41	--	--	--	--	--	--	7,722	1,139	8,902	1,201
Canada	5	355	--	--	6,991,920	281	922	--	329	680	6,994,492	224,088
Chile	--	--	--	--	--	2,000	12,958	--	--	1,093	16,051	1,438
Dahomey	--	--	--	--	14,893	--	--	--	--	--	14,893	1,067
Finland	--	--	--	--	--	--	--	--	--	1,515	1,515	187
France	--	30	--	--	--	--	--	--	7,496	867	8,393	881
Germany, West	--	527	--	583	10,016	--	--	20	42,335	5,684	59,165	7,892
Israel	--	--	--	--	87,401	11,828	5,953	80	--	--	105,262	5,619
Italy	807	--	--	(1)	--	--	--	--	--	60	867	1,787
Japan	--	229	--	107	--	--	--	--	--	2,917	3,253	6,237
Netherlands	--	21	--	--	--	--	--	218	--	1,512	1,751	1,040
Norway	--	--	--	--	--	--	6,101	--	--	--	6,101	515
Spain	449	--	173	--	--	--	--	--	--	427	1,049	1,267
Sweden	--	602	247	--	--	--	--	--	--	20	869	427
U.S.S.R	--	--	--	--	41,249	--	--	--	--	--	41,249	1,459
United Kingdom	--	66	7	461	106	--	--	--	--	494	1,134	691
Other	8	--	10	--	--	--	--	--	--	r 110	r 128	147
Total	1,417	1,871	437	1,151	7,145,585	14,109	25,934	318	57,882	r 16,518	r 7,267,222	256,082
1975:												
Argentina	20	--	--	--	--	--	--	--	--	--	20	27
Belgium-Luxembourg	--	221	--	--	--	--	--	--	8,267	108	8,596	1,030
Canada	--	64	--	--	5,954,187	2	2,045	20	196	2,264	5,958,778	239,357
Chile	--	--	--	--	3,360	--	2,828	--	--	--	6,188	749
Congo	--	--	--	--	61,007	--	--	--	--	--	61,007	3,679
France	--	1,342	--	--	--	--	--	--	22,801	1,146	25,289	3,143
Gaza Strip	--	--	--	--	3,673	--	--	--	--	--	3,673	62
Germany, West	--	819	--	149	11,039	--	--	85	45,704	5,357	63,153	10,033
Israel	--	--	--	--	81,580	35,787	14,877	600	--	130	132,974	15,243
Italy	201	--	--	--	--	--	--	--	--	23	224	300
Japan	--	4,366	--	17	--	--	--	--	--	2,099	6,482	7,388
Netherlands	--	79	--	--	--	--	--	--	--	516	595	290
Norway	--	--	--	--	--	--	5,197	--	--	--	5,197	796
Spain	280	--	22	--	--	--	--	--	--	153	455	671
Sweden	--	280	201	--	--	--	--	--	--	62	543	259
Switzerland	--	--	1	--	--	--	--	--	--	40	41	107
U.S.S.R	--	--	--	--	16,151	--	--	--	--	--	16,151	1,123
United Kingdom	--	(1)	--	131	326	2	--	--	--	679	1,138	729
Other	2	--	--	--	608	--	--	60	--	1,155	1,825	286
Total	503	7,171	224	297	6,131,931	35,791	24,947	765	76,968	13,732	6,292,329	285,272

r Revised.
[1] Less than 1/2 unit.

WORLD REVIEW

Australia.—The Texada Mines, Pty. Ltd.'s potash refinery at Lake McLeod in Western Australia was placed on standby in September because the planned Southeast Asian market never developed. There were no immediate plans to reopen the facility.

Brazil.—Exploitation of the Sergipe potash deposits remained stalled because of objections by Petróleo Brasileiro S.A., a 50% participant in the project, that the proposed solution mining methods would interfere with petroleum activities in the area. Brazil is completely dependent on imports for its potash supply.

Canada.—Annual production, all in Saskatchewan, remained near 6 million tons of K_2O equivalent in 1975 although production at several mines was interrupted by either strikes or fires. Over 80% of production was exported, mostly to the United States. Yearend inventories increased from 132,000 tons in 1974 to 1,091,000 tons in 1975 as a result of decreased demand. Only 5% of production was used domestically.

The Canadian Potash Producers Association filed suit in Saskatchewan provincial court in Regina maintaining that both the reserves tax and the prorationing fee on potash are unconstitutional or illegal. The Saskatchewan Government decided to oppose this up to the Canadian Supreme Court, if necessary, and litigation possibly lasting up to 3 years was indicated. At yearend, most producing companies were behind in payments of the reserves tax. Industry claimed that the reserves tax equaled one-quarter to one-half of pretax profits. Planned expansions in capacity, claimed by industry to have totaled $200 million, were deferred or cancelled in opposition to the expressed wishes of the Saskatchewan Government.

The Saskatchewan Government announced in November that it would seek to acquire some or all of the producing potash mines in that Province, a majority of which are U.S. owned and that if agreement with the owners on terms of sale was not reached, the Province would expropriate the properties. Enabling legislation was passed by the Saskatchewan Legislature in January 1976. The necessary funds were being sought actively by the Premier of Saskatchewan.

An agreement was signed in January 1976 by the Province of New Brunswick and International Minerals & Chemical Corp. (Canada) Ltd. granting that corporation the rights to explore and develop a potash and salt prospect near Salt Springs in Kings County in southern New Brunswick. A 3,000-foot drill hole at Salt Springs intersected 51 feet of potash containing an average of 31.6% K_2O near the 2,000-foot depth; this was underlain by salt averaging more than 98% NaCl. The corporation was committed to spend a minimum of $1 million on an approved exploration program during the initial phase of work.

The Potash Co. of America continued drilling in 1975 on its Sussex potash-salt property in New Brunswick and was the only other private firm conducting potash exploration in that Province. A total of 21 holes had been drilled by yearend and the company was seeking an agreement with the New Brunswick Government to permit further exploration.

Chile.—Sociedad Química y Minera de Chile, S.A., announced that its production of potassium nitrate would be increased to approximately 40,000 short tons of K_2O equivalent per year. A joint Chilean-U.S. team continued examining lithium-potassium deposits in northern Chile.

France.—A lack of agreement existed among Western European countries concerning reduction of industrial pollution of the Rhine River. Approximately one-third of chloride pollution in the Rhine comes from salt-dumping actions of the French potash mines. France withdrew in 1975 from a multination cost-sharing proposal involving West Germany, Switzerland, and the Netherlands on the basis that it was too costly. Legal action seeking damages by a Netherlander citizens' group was rejected in a Rotterdam court.

Italy.—After acquiring controlling interest in the potash mines of Sicily, the only producing units in Italy, the Sicilian government continued to operate the mines at low productivity and at about two-thirds capacity because of a lack of managerial and technical talent and a lack of employee incentive, although much of the equipment was quite modern. A plan was presented to the Sicilian government for a national government-controlled agency to acquire control of the Sicilian potash industry from the Sicilian government.

Jordan.—The Arab Potash Company of Jordan announced plans for a \$200 million project to recover at least 1 million tons per year of potash from the Dead Sea. The first processing step will be solar evaporative recrystallization in a series of ponds with a total area of 34 square miles. The planned completion date for the separation plant was 1981. The pilot project received financial aid in July from the International Development Association.

Laos.—Deposits of sylvite, reportedly containing at least 1 million tons of K_2O equivalent, were found north and east of Vientiane near the Thailand border. Test drillings made about 10 miles north of Vientiane located a bed approximately 100 feet thick described as a crystalline intergrowth of sylvite and halite assaying around 30% K_2O. Development of this resource, which would require large investment in transportation as well as mining and beneficiation facilities, could create a major supply of potash for the Asian market. Much more drilling is required to estimate the magnitude of this resource.

Mexico.—Plans were announced by Guanos y Fertilizantes de Mexico S.A. to construct, by late 1976, an approximately 20,000-ton-per-year plant at Salamanca to treat alunite ore. The plant will use a process developed by the Guanajuato University whereby alunite is ammoniated to yield potassium and ammonium sulfates in solution and a hydrated alumina residue.

Netherlands.—Royal Dutch Shell announced plans to exploit the large underground salt deposits at Veendam in the north of the Netherlands. A trial quantity of crude brine containing potassium and magnesium salts was produced from the deposits and experiments were begun to develop a separation method.

Spain.—Potash reserves of Potassa de Navarra, the State-owned potash producer in northern Spain, were reportedly nearly exhausted and plans were announced to explore and develop new zones within a carnallite deposit near Pamplona. Planned production of beneficiated potash from this operation was 165,000 tons of K_2O per year by 1970.

One of the two privately owned potash producers, Minas de Potassa de Suria, announced plans to increase production by one-third to 220,000 tons of K_2O per year in 1980.

U.S.S.R.—Reported production of potash increased 18% compared with 1974. New potash mine and plant construction continued, particularly in the Uralkali Combine where two large mines, Berezniki no. 4 and Novosolikamsk, each with an annual capacity of about 3 million short tons of ore, were being built. Berezniki no. 3 came on-stream providing an additional U.S.S.R. capacity of 350,000 tons of K_2O. Performance of the industry was reportedly impaired by lack of sufficient transport to move the product from the mines.

Approximately 32% of the potash produced in the U.S.S.R. was exported—about 65% to centrally controlled economy countries (mainly Poland); about 20% to Western Europe (mainly Belgium-Luxembourg); about 10% to Asia and Oceania (mainly Japan); and about 5% to other countries.

United Kingdom.—Essential construction of mine and plant by Cleveland Potash, Ltd., at Boulby, Yorkshire, was completed and commercial operation began on a limited basis. Reported 1975 production was 37,000 tons of K_2O equivalent. Considerable mining development was required before full capacity, 550,000 tons of K_2O per year, expected by the end of 1976, could be reached. The sylvite ore contains an average of 25% K_2O and estimated reserves are approximately 100 million tons of K_2O equivalent. The ore contains some clay which may cause problems during froth flotation beneficiation.

Table 11.—Marketable potash: World production by country

(Thousand short tons, K_2O equivalent)

Country [1]	1973	1974	1975 [p]
Canada [2]	[r] 4,698	6,041	5,992
Chile	28	14	13
China, People's Republic of [e 3]	330	420	440
Congo (Brazzaville)	[r] 297	318	309
France	2,494	2,508	2,298
Germany, East	2,818	3,157	3,328
Germany, West	2,809	2,888	2,450
Israel [4]	[r] 585	669	789
Italy	[r] 148	169	160
Spain	[r] 522	436	506
United Kingdom	--	--	37
U.S.S.R	[r] 6,523	7,260	8,600
United States	2,603	2,552	2,501
Total	[r] 23,855	26,432	27,423

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, Australia produced small, unreported quantities of marketable potash in 1974 and 1975 from newly developed facilities.

[2] Series revised to show actual production; previous editions have provided shipment statistics.

[3] Data for year ending June 30 of that stated as reported in the British Sulphur Corp. Ltd., Statistical Supplement No.12, November-December 1975, London, pp. 18–19.

[4] April 1 through March 31 (the year is offset by 3 months).

TECHNOLOGY

Experimental studies by the Bureau of Mines on the insoluble fines problem inherent in Carlsbad potash ores revealed that about 87% of the insoluble fines can be removed by selective flocculation prior to froth flotation. The crude ores contained about 16% K_2O and 3% clay fines. The subsequent flotation yielded a 55% K_2O concentrate containing less than 0.5% insolubles with an 86% K_2O recovery.

The Great Salt Lake Minerals & Chemicals Corp. engineered a Bureau of Mines-developed froth flotation process to concentrate low-grade potash solar evaporites from Great Salt Lake brines through the pilot plant stage, and constructed a commercial flotation plant with a capacity of 6 tons of K_2O equivalent per hour of potassium sulfate product.

Calculations indicate that potassium seed requirements for possible commercial magnetohydrodynamic electrical generation by the year 2000 will not have a major impact on the potash industry. Assuming operation in the year 2000 of 100 power station units, an optimistic projection, each generating 2,000 megawatts and with an assumed potassium seed loss of 2%, the calculated total seed loss is about 300,000 tons per year of K_2O equivalent; this is less than 3% of projected total domestic potash consumption in the year 2000. This calculated seed loss is about 0.2% of K_2O equivalent per ton of coal burned.

Studies made[4] by Hazen Research, Inc., under a U.S. Bureau of Mines contract on muriate of potash recoverability from geothermal brines in the Imperial Valley in southern California indicated economic feasibility but only if recovered as a coproduct. These brines contain up to about 2% K_2O and represent a significant potash resource.

[4] Hazen Research, Inc. Process Technology for Recovering Geothermal Brine Materials. HRI Project 1370 (under Bureau of Mines Contract HO 144104), Feb. 4, 1975, 209 pp.; available from National Technical Information Service, Springfield, Va., PB 241867/AS.

Pumice and Volcanic Cinder

By Arthur C. Meisinger [1]

Total U.S. production of pumiceous materials in 1975 was the third largest in quantity (3.89 million tons) and the highest in value ($11.2 million) in history. Average values for crude and prepared material in 1975 increased 19% and 17%, respectively, over values reported in 1974. Higher prices as well as continued inflationary costs, particularly for volcanic cinder sold or used, for all major end uses except landscaping, contributed significantly to the increased value of domestic production.

Oregon led all producing States in 1975 with a record high production of 1.47 million tons, valued at a record high of $3.9 million; the State also led in the number of active operations with 86. The combined output of Arizona and Oregon accounted for 60% of total domestic output.

The combined use of pumiceous materials for road construction and concrete admixtures and aggregate accounted for 84% of U.S. consumption (excluding imports) compared with 82% in 1974.

U.S. exports of pumice and pumicite decreased 57% in quantity and 15% in value from those of 1974. The principal export destination for pumice in 1975 was West Germany, followed by Canada and 13 other countries. Imports of pumice declined drastically below those of 1974. Decreases of 50% in quantity and 65% in value for imported pumice generally reflected the slump in construction activity in 1975, particularly for concrete masonry products using pumice. Greece and Italy continued to be the major import sources of pumice for the United States.

DOMESTIC PRODUCTION

The quantity of pumiceous materials (pumice, pumicite, volcanic cinder, and scoria) produced in the United States in 1975 was 3.89 million tons, or only 1.1% under the 1974 figure of 3.94 million tons. However, the value of domestic production increased nearly 23% from $9.1 million in 1974 to a record high of $11.2 million. Inflationary costs and substantial price increases by producers of volcanic cinder contributed largely to the overall increase in the total value of pumiceous materials in 1975.

The quantity of pumice and pumicite produced in 1975 declined for the first time in 4 years, from 873,000 tons in 1974 to 790,000 tons, and value of production was $3.5 million compared with $3.7 million in 1974. Production of volcanic cinder and scoria increased in both quantity and value compared with that in 1974. Volcanic cinder and scoria comprised 80% of the domestic output of pumiceous materials compared with 78% in 1974.

Domestic output in 1975 came from 91 individuals, firms, and governmental agencies producing from 267 operations in 11 States, compared with 92 producers and 289 operations in 12 States in 1974. Oregon led all the producing States in number of active operations with 86, followed by California with 75, and Arizona with 47.

The combined output of pumiceous materials (primarily volcanic cinder) in Oregon and Arizona in 1975 was 2.3

[1] Industry economist, Division of Nonmetallic Minerals.

million tons, or 60% of the national total. Oregon's output was a record 1.47 million tons valued at $3.94 million, and was attributed to increased use of volcanic cinder for road construction and maintenance in National Forest lands throughout the State during the year.

Other States with significant output of pumiceous materials in 1975 were New Mexico, 397,000 tons; California, 348,000 tons; and Hawaii, 318,000 tons. Volcanic cinder (including scoria) was produced in nine of the eleven States and in American Samoa.

Table 1.—Pumice, pumicite, and volcanic cinder sold or used in the United States [1]
(Thousand short tons and thousand dollars)

Year	Pumice and pumicite		Volcanic cinder		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1971	540	1,396	2,851	3,818	3,391	5,214
1972	790	1,878	3,023	4,661	3,813	6,539
1973	824	3,612	3,113	5,269	3,937	8,881
1974	873	3,669	3,064	5,452	3,937	9,121
1975	790	3,493	3,102	7,710	3,892	11,203

[1] Value f.o.b. mine, 1971; values f.o.b. mine or mill, 1972–75.

Table 2.—Pumice, pumicite, and volcanic cinder sold or used by producers in the United States, by State
(Thousand short tons and thousand dollars)

State	1974		1975	
	Quantity	Value	Quantity	Value
Arizona	846	865	856	1,294
California	909	3,219	348	2,762
Hawaii	385	792	318	912
Idaho	108	182	111	187
New Mexico	471	1,466	397	1,280
Oregon	915	1,887	1,470	3,937
Utah	15	19	17	23
Washington	(1)	1	--	--
Other States [2]	288	690	375	808
Total	3,937	9,121	3,892	11,203
American Samoa	27	183	15	15

[1] Less than ½ unit.
[2] Colorado, Kansas, Nevada, and Oklahoma.

CONSUMPTION AND USES

The combined use of pumiceous materials for road construction and concrete admixtures and aggregate accounted for 84% of U.S. consumption compared with 82% in 1974. In 1975, landscaping use comprised 4%; railroad ballast, 8%; and abrasives and other uses, 4%. Compared with consumption in 1974, pumiceous materials used in landscaping increased nearly 48% and that used in road construction, about 10%. However, use in concrete admixture and aggregate in 1975 declined 10%; in railroad ballast, 26%; in abrasives, 47%; and in other uses, 27%.

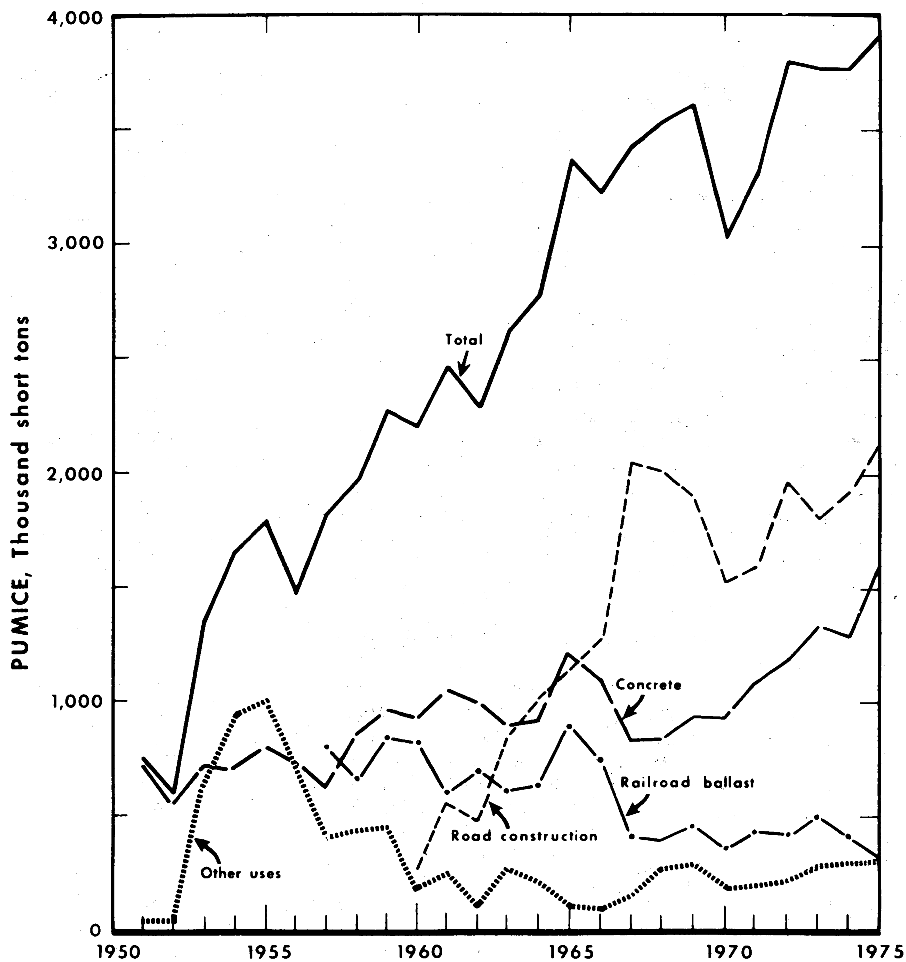

Figure 1.—Pumice and volcanic cinder sold or used by producers in the United States, by use.

Table 3.—Pumice, pumicite, and volcanic cinder sold and used by producers in the United States, by use
(Thousand short tons and thousand dollars)

Use	1974		1975	
	Quantity	Value	Quantity	Value
Abrasive (includes cleaning and scouring compounds)	17	527	9	547
Concrete admixture and concrete aggregate	1,284	3,363	1,158	3,322
Landscaping	111	1,107	164	1,257
Railroad ballast	420	462	310	455
Road construction (includes ice control and maintenance)	1,927	2,517	2,121	4,582
Other uses [1]	179	1,145	130	1,039
Total [2]	3,937	9,121	3,892	11,203

[1] Includes absorbents, heat-or-cold insulating medium, roofing granules, soil conditioners, and miscellaneous uses.
[2] Data may not add to totals shown because of independent rounding.

PRICES

The weighted average value for pumiceous materials produced domestically in 1975 was $2.88 per ton compared with $2.32 per ton in 1974. The average value for crude pumice, pumicite, and volcanic cinder sold and used by producers increased 19% from $1.10 per ton in 1974 to $1.31 per ton, and the average value for prepared material rose 17% from $3.72 per ton to $4.36 per ton.

Increases in average prices for all major end uses of pumiceous materials (except landscaping) were reported in 1975. Compared with prices in 1974, the average price per ton for pumice and volcanic cinder used in abrasives, including cleaning and scouring compounds, was $60.78, a $29.78 increase; for concrete admixtures and aggregate, $2.87, a $0.25 increase; for railroad ballast, $1.47, a $0.37 increase; for road construction, $2.16, a $0.85 increase; and for other uses, $7.99, a $1.59 increase. The average price for landscaping decreased $2.31 per ton from $9.97 in 1974 to $7.66 in 1975.

No changes were reported in price quotations for pumice by trade publications in 1975. Quoted prices in American Paint and Coatings Journal at yearend, per pound, bagged f.o.b. New York or Chicago, were powdered, $0.0445 to $0.08; and lump, $0.0665 to $0.09. Quoted prices in Chemical Marketing Reporter at yearend were as follows for domestic grades, bagged in 1-ton lots: Fine, $0.0765 to $0.1140 per pound; medium, $0.1160 per pound; and coarse, $0.094 per pound. Prices from the same source for imported (Italian) silk-screened, pumice bagged in 1-ton lots, were as follows: Fine, $138 per ton; medium, $150 per ton; and coarse, $140 per ton. The price of imported small and large lump was quoted at $275 per ton.

FOREIGN TRADE

Exports of pumice and pumicite totaled 1,252 tons valued at slightly more than $1 million in 1975, compared with 2,911 tons and $1.2 million in 1974, a decrease of 57% in quantity, but only 15% for the value. Pumice shipments were made to 15 countries, of which West Germany received 729 tons (58%); Canada, 334 tons (27%); and the remaining countries, 189 tons, (15%).

The quantity and value of pumice imports for consumption decreased significantly from that of 1974. The quantity decrease was 50% in 1975, or 147,500 tons less than in 1974, and the value of imports declined 65%, or nearly $1 million less than in 1974. All import classes showed declines in 1975; crude or unmanufactured (61%), wholly or partly manufactured (69%), manufacture of concrete masonry products (50%), and manufactured products, n.s.p.f., value (5%).

Pumice stone, TSUS No. 519.05, for use in concrete products, continued to be admitted into the United States duty free. Duties (unchanged from 1974) for other pumice products at yearend were as follows: TSUS No. 519.11, crude or crushed, valued not over $15 per ton, 0.02 cent per pound; TSUS No. 519.14, crude or crushed, valued over $15 per ton, 0.04 cent per pound; TSUS No. 519.31, in grains or ground, pulverized or refined, 0.17 cent per pound; and TSUS No. 519.93 millstones, abrasive wheels, and abrasive articles, n.s.p.f., and 523.61 articles, n.s.p.f., 7% ad valorem.

Table 4.—U.S. exports of pumice

Year	Quantity (short tons)	Value (thousands)
1972	256	$34
1973	3,095	765
1974	2,911	1,211
1975	1,252	1,027

Table 5.—U.S. imports for consumption of pumice, by class and country

Country	Crude or unmanufactured		Wholly or partly manufactured		Used in the manufacture of concrete masonry products		Manufactured n.s.p.f.
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Value (thousands)
1974:							
Greece	--	--	--	--	202,588	$394	--
Italy	8,415	$228	2,167	$152	79,535	663	$9
Mexico	--	--	--	--	215	4	48
Other [1]	--	--	(2)	1	--	--	23
Total	8,415	228	2,167	153	282,338	1,061	80
1975:							
Canada	--	--	120	7	--	--	3
Greece	--	--	--	--	131,998	298	--
Italy	3,260	77	555	43	9,425	32	9
Mexico	--	--	--	--	22	(2)	58
Other [3]	--	--	--	--	--	--	6
Total	3,260	77	675	50	141,445	330	76

[1] Canada, West Germany, Italy, Japan, U.S.S.R., and the United Kingdom.
[2] Less than ½ unit.
[3] Austria, Japan, Mexico, the United Kingdom, and Taiwan.

Table 6.—Pumice and related volcanic materials: World production by country
(Thousand short tons)

Country [1]	1973	1974	1975 [p]
Argentina [2]	38	17	[e] 17
Austria: Pozzolan	27	20	14
Cape Verde Islands: Pozzolan	13	[e] 17	[e] 17
Chile: Pozzolan	157	179	[e] 190
Costa Rica	2	[e] 2	[e] 2
Dominica	125	[e] 126	126
Egypt	(3)	(3)	(3)
Ethiopia [4]	(3)	--	--
France:			
Pumice [e]	1	1	1
Pozzolan and lapilli	[r] [e] 830	955	759
Germany, West (marketable)	4,182	2,316	2,111
Greece:			
Pumice	835	574	[e] 550
Pozzolan	798	905	[e] 910
Guadeloupe: Pozzolan	176	193	[e] 190
Guatemala: Volcanic ash (for cement)	[e] 55	[r] [e] 35	17
Iceland	21	[5] 8	[5] 4
Italy:			
Pumice and pumiceous lapilli [e]	[r] 1,100	[r] 1,100	1,100
Pozzolan [e]	[r] 4,600	[r] 4,600	4,600
Martinique: Pumice [e]	100	75	85
New Zealand	63	78	80
Spain [6]	195	212	[e] 220
United States (sold or used by producers):			
Pumice and pumicite	824	873	790
Volcanic cinder [7]	3,150	3,091	3,117
Total	[r] 17,292	15,377	14,900

[e] Estimate. [p] Preliminary. [r] Revised.
[1] Pumice is also produced in Iran, Japan, Mexico, Turkey, and the U.S.S.R. (sizable quantity), but data on production are not available.
[2] Unspecified volcanic materials produced mainly for use in construction products.
[3] Less than ½ unit.
[4] Includes Eritrea.
[5] Exports.
[6] Includes Canary Islands.
[7] Includes American Samoa.

Rare-Earth Minerals and Metals

By Rebecca P. Smith [1]

Production of rare-earth oxide (REO) contained in bastnäsite and monazite concentrates decreased 23% in 1975, reflecting the low demand for rare earths in most industries. However, some applications using rare earths increased, notably X-ray phosphors for intensifying screen images and rare-earth-cobalt permanent magnets. Despite these changes, the overall end-use consumption pattern was similar to that of 1974. Petroleum catalysts continued to be the major consumer, with metallurgical applications second. The ceramic and glass industry was another major consumer.

Molycorp Inc., and the Davison Div. of W. R. Grace & Co. continued to be the major processors of rare-earth minerals. Production of rare-earth compounds and metals was adequate to meet market demand. There was a general increase in stocks during the year, and many rare-earth companies were not operating at full capacity near the end of 1975.

U.S. exports of rare-earth concentrates, compounds and metals declined in 1975. Imports of REO, mainly in the form of monazite, increased significantly. The major supplying countries for monazite were Malaysia and Thailand; for compounds and metals, Austria, Brazil, France, Japan, West Germany, and the United Kingdom; and for yttrium concentrate, Canada.

Legislation and Government Programs.—At the end of 1975, 7,398 tons (dry) of REO equivalent was held in the General Services Administration (GSA) stockpile. Disposals for the year totaled 1,050 tons of contained REO. Government stocks of yttrium oxide (Y_2O_3) remained unchanged at 237 pounds.

DOMESTIC PRODUCTION

Concentrate.—Domestic production of REO in bastnäsite and monazite concentrates decreased about 23% in 1975 from the record high of 1974. Production in 1975 was also below the high level in 1973, but was higher than in previous years. Bastnäsite continued to be the major source of rare earths, the remainder, less than 10%, was produced from monazite.

According to Molycorp's annual report, its Mountain Pass, Calif., operation produced 16,500 tons of REO contained in bastnäsite concentrate during 1975; 1974 production was 21,950 tons.

Titanium Enterprises, owned jointly by American Cyanamid Co. and Union Camp Corp., continued to recover monazite as a byproduct of mining a beach sand deposit near Green Cove Springs, Fla., for titanium minerals and zircon. During 1975, monazite production remained at the 1974 level.

The only other domestic producer of monazite was Humphreys Mining Co. Again the monazite was recovered as a byproduct of mining heavy-mineral beach sand. The dredging operation was located near Hilliard, Fla., and the wet heavy concentrates were trucked to the company dry plant at Folkston, Ga., for processing. Monazite production increased about 13% over that of 1974, which was abnormally low because the dredging operations were relocated.

Buttes Gas & Oil Co. were conducting feasibility studies on a large deposit of titanium in southwestern Colorado. The deposit was reported to contain significant

[1] Physical scientist, Division of Nonferrous Metals.

amounts of rare-earth elements that could be recovered during processing for titanium.

Compounds and Metals.—In 1975, there were only two major processors and producers of rare-earth compounds, Molycorp and the Davison Div. of W. R. Grace & Co., Chattanooga, Tenn. Molycorp, with processing plants at Mountain Pass, Calif., Louviers, Colo., and York, Pa., continued to be the principal domestic producer. Molycorp's production declined, compared with 1974 production, and sales were also down, $18.9 million compared with $23.1 million in 1974.

A 3-year program to expand mill and chemical-plant production capacities at Mountain Pass was completed at a cost of about $7 million. The new facilities are expected to be operational in 1976. The new capacities of the mill and chemical plant were 60 million and 30 million pounds of rare-earth oxide, respectively.[2]

Producers of high-purity rare-earth oxides and compounds were Molycorp; W. R. Grace; Nucor Corp., Research Chemicals Div., Phoenix, Ariz.; Atomergic Chemetals Corp., Plainview, N.Y.; and Transelco Inc., Penn Yan, N.Y. In addition, high-purity rare-earth compounds and metals were also sold from the remaining stocks held by a former rare-earth processor, Michigan Chemical Corp., St. Louis, Mich.

Mischmetal production during 1975 was about the same as that in 1974; however, shipments were down. The three domestic companies that produced mischmetal during 1975 were Ronson Metals Corp., Newark, N.J.; Reactive Metals and Alloys Corp. (REMACOR), West Pittsburgh, Pa.; and Rare Earth Metals Co. of America (REMCOA), owned jointly by Aluminum Co. of America and Molycorp, Arnold, Pa. REMACOR was formed from the former Rare Earth Industries and began mischmetal production in March. REMCOA started production of mischmetal from its 125-ton-per-year demonstration unit during the fourth quarter.

Rare-earth-ferrosilicon alloys were produced by three companies: Foote Mineral Company, Exton, Pa.; Ohio Ferro-Alloys Corp., Canton, Ohio; and Union Carbide Corp., Alloy, W. Va.

Nucor was the major producer of high-purity rare-earth metals; the predominate producer of yttrium compounds was Molycorp. The yttrium was processed from yttrium-rare-earth concentrates imported from Canada.

CONSUMPTION AND USES

Domestic rare-earth processors consumed an estimated 12,600 tons of REO contained in raw materials in 1975. Consumption of bastnäsite and monazite decreased 32% and 41%, respectively, from that of 1974. Shipments of rare-earth and yttrium products from processing plants to domestic end-use consumers were about 7,500 tons of contained REO, valued at about $28 million.

The approximate quantitative percentage distribution of rare-earth and yttrium consumption by end-use, based on information supplied by primary processors and certain consumers, was as follows: Petroleum cracking catalysts, 45%; metallurgical, including nodular iron and steel, other alloys, and mischmetal, 33%; ceramics and glass, 16%; and miscellaneous, including electrical, arc carbons, and research, 6%. Shipments of high-purity rare-earth and yttrium oxides and metals, although accounting for about 28% of value shipped, represented less than 1% of the total weight of shipments.

The use of rare-earth zeolites in cracking catalysts to increase gasoline yields from petroleum feedstocks continued to be the single largest use of rare earths. Metallurgical usage of rare-earth metals, mostly as additives to ductile iron and steel, declined slightly. This was a result of low demand for high-strength low-alloy steels (especially in arctic pipeline), and from delays in expansion of these steels into the automobile industry for weight reduction. Rare earths are added mostly as mischmetal or rare-earth silicides. Beginning in 1975, ferrosilicon-mischmetal alloy containing 50% mischmetal was available. In previous years, alloys of 30% to 35% mischmetal were common. Mischmetal in customized ingot canisters weighing up to 650 pounds was available for the first time for plunging into molten steel ladles. Another new development was ductile mischmetal wire available for automatic continuous feed into molten steel.

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[2] Molycorp Inc. 1975 Annual Report. P. 5.

The production of lighter and striker flints continued to be a major consumer of mischmetal. Other rare-earth alloys and metals were used in the production of high-temperature alloys and superalloys.

The glass industry continued to be a major consumer of rare-earth compounds, particularly cerium oxide. The established uses of cerium oxide are as an abrasive for polishing plate glass; an additive in eyeglasses, television tubes, and camera lenses; and as a decolorizing agent in refining clear glass. Other rare-earth oxides—praseodymium, erbium, holmium, and neodymium—were used as colorants in glass. Lanthanum oxide was used to improve the refractive quality of camera lenses.

The use of rare-earth elements in X-ray phosphors increased about 250% in 1975. Terbium-activated gadolinium or lanthanum oxysulfide phosphors were used to intensify X-ray screen images. Because of the effectiveness of these phosphors, they allowed faster exposure of X-ray film, which reduced patient X-ray dosages as much as 80%. In 1975, an estimated 40,000 pounds of REO in phosphors was consumed; in 1974, consumption was 16,000 pounds.[3]

Yttrium and europium oxide were consumed as key constituents of the red phosphor in color television tubes.

Crystals of yttrium (or gadolinium)—aluminum (or iron) garnet were used as microwave filters and control devices, as simulated diamonds and, when doped with neodymium or erbium, as lasers. Minor quantities of gadolinium-gallium garnet in thin-film, magnetic bubbles were used in communication and computer systems.

Significant quantities of rare-earth oxides and fluorides were used in carbon-arc lamps, which emit a high-intensity white light, used in searchlights and color motion picture lights.

The consumption of rare-earth-cobalt alloys in permanent magnets continued to expand. These high-energy magnets, which are two to three times more powerful than conventional permanent magnets, are used mainly in small electric motors and generators, electric wristwatches, and electronic tubes. Samarium and mischmetal predominated as the rare-earth elements alloyed with cobalt.

STOCKS

At yearend 1975, bastnäsite stocks held by the principal producer and four other chemical processors increased 176% compared with those at the beginning of the year. Monazite stocks held by the two producers and two processing companies increased 68% during the year. Stocks of rare-earth compounds and mixtures generally increased during the year. Mischmetal stocks held by the three producers remained steady. Stocks of high-purity metals held by six companies decreased 70% in 1975.

PRICES

Prices for domestic monazite during 1975 were similar to 1974 prices. The average declared value of imported monazite from Malaysia and Thailand increased from $152 per short ton in 1974 to $207 per short ton in 1975. The average price per short ton of Australian monazite (minimum 60% REO plus ThO_2) as quoted in Metal Bulletin (London) remained constant during 1975 at $203. Quoted prices for Malaysian xenotime concentrate containing a minimum 25% Y_2O_3 decreased in 1975 to $2 to $3 per pound c.i.f. from $3 to $5 in 1974.

Prices for unleached, leached, and calcined bastnäsite containing 55% to 60%, 68% to 72%, and 85% to 90% REO, respectively, were increased on March 1, 1975, from 36, 41, and 48 cents per pound REO, to 45, 50, 60 cents, respectively. Prices quoted were f.o.b. Mountain Pass or Nipton, Calif., in 100-pound paper bags or 55-gallon steel drums in truckload or carload lots.

Prices of rare-earth compounds increased for many products during 1975, reflecting the increased price of the concentrate and rising production cost. Most prices of rare-earth products are negotiable if purchased in large quantities. A sampling of quoted prices at yearend of rare-earth compounds,

[3] The Northern Miner (Canada). Rare-Earth Application for X-rays Increases. V. 61, No. 46, Jan. 29, 1976, p. 12.

per pound f.o.b. plant, were as follows: Lanthanum—rare-earth hydrate, 75% REO, $0.75; rare-earth chloride, 46% REO, $0.50; rare-earth carbonate, 65% REO, $1.30; and cerium fluoride, 62% REO, $1.25.

Quotations on cerium hydrate, 90% CeO_2 of total REO, increased to $2.65 per pound of contained oxide for a minimum of 7,500 pounds from $2.15 in 1974.

Prices quoted in the American Metal Market for 1-pound ingots in 50- to 100-pound lots of 97% didymium, and cerium-free mischmetal were $15 and $12, respectively, f.o.b. plant. Compared with 1974 prices, the price of didymium remained stable, but that of cerium-free mischmetal increased $7 per pound. Mischmetal of 99.8% purity was quoted at $3.45 per pound same basis, an increase of $0.20 from 1974. Quoted prices of rare-earth metals for magnet use remained at the 1974 levels: Cerium, $18; lanthanum, $27.50; praseodymium, $62.50; and samarium, $75 (all 99% purity and in 10- to 100-pound amounts).

Table 1.—Prices of high-purity rare-earth oxides, salts, and metals in 1975 [1]
(Dollars per pound)

Element	Oxide [2]	Salts [3]	Metal [4]
Cerium	6.50	12.00	50.00
Dysprosium	40.00	27.00	130.00
Erbium	45.00	27.00	160.00
Europium	515.00	225.00	3,000.00
Gadolinium	50.00	26.00	220.00
Holmium	120.00	80.00	300.00
Lanthanum	5.00	12.00	50.00
Lutetium	2,000.00	1,100.00	6,000.00
Neodymium	18.00	12.00	110.00
Praseodymium	32.00	16.00	170.00
Samarium	32.00	16.00	155.00
Terbium	350.00	175.00	845.00
Thulium	1,000.00	550.00	2,600.00
Ytterbium	85.00	70.00	240.00
Yttrium	30.00	15.00	150.00

[1] Research Chemicals, Nucor Corp., f.o.b. Phoenix, Ariz. For large quantities, prices may be negotiable. Other producers may have different prices on some items.
[2] Minimum 99.9% purity, more than 1 pound.
[3] Minimum 99.9% purity, more than 1 pound; includes chlorides, nitrates, sulfates, oxalates, and acetates.
[4] Minimum 1 pound, ingot form.

FOREIGN TRADE

Exports of bastnäsite concentrates contained about 3,400 tons of REO, according to the sole producer, Molycorp. This was substantially down from the 4,700 tons exported in 1974. Exports of ferrocerium and other pyrophoric alloys to Canada, the Netherlands, and 23 other countries decreased 48% to 100,279 pounds valued at $299,994. The average unit value was $2.99 per pound. Shipments of compounds and mixtures of rare-earth metals, including yttrium and scandium, went to 27 countries. West Germany and Austria received about 65% of the shipments, which totaled 1,465,364 pounds valued at $2,719,918. This was a 71% decrease in shipments from 1974.

Monazite imports (table 2), mostly from Malaysia, increased to 2,565 tons with an average unit value of $207 per short ton. Imports of cerium oxide, predominately from France, declined to 624 pounds valued at $5,216 in 1975 compared with 31,390 pounds valued at $100,977 in 1974. The average unit value increased 61% to $8.36 per pound. Imports of cerium salts and cerium ore from the United Kingdom totaled 9,600 and 2,139 pounds, respectively, with an average unit price of $1.01 and $10.61 per pound, respectively. Imports of other cerium compounds, predominately from France, totaled 6,189 pounds valued at $28,975. The unit value ranged from $3.46 (France) to $66.02 (Switzerland) per pound.

Imports of rare-earth metals, scandium, and yttrium totaled 3,207 pounds valued at $87,818. The major supplier was the U.S.S.R. with 2,659 pounds valued at $58,336.

Imports of ferrocerium and other pyrophoric alloys decreased 41% to 33,852 pounds valued at $186,640. France supplied 65% of the total valued at $112,287, followed by Japan with 31% valued at $65,053. Other suppliers were the United Kingdom, Austria, West Germany, and Singapore. Imports of rare-earth metals and alloys, predominately from the United Kingdom and Brazil, increased 56% to 19,518 pounds valued at $111,857. The average unit value decreased from $22.64 per pound in 1974 to $5.73 per pound in 1975 owing to increased mischmetal imports from Brazil. Imports of other rare-earth metals, entirely from West Germany, totaled 22 pounds valued at $355.

Table 2.—U.S. imports for consumption of monazite, by country

Country	1971		1972		1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	1,802	$219	--	--	--	--	--	--	--	--
Malaysia	1,571	165	894	$89	1,991	$244	984	$154	103	$24
Thailand	--	--	--	--	110	10	336	47	2,462	508
Total	3,373	384	894	89	2,101	254	1,320	201	2,565	532
REO content [e]	1,855	XX	492	XX	1,156	XX	726	XX	1,411	XX

[e] Estimate. XX Not applicable.

Table 3.—U.S. imports for consumption of rare-earth metals [1]

Country	1973		1974		1975	
	Pounds	Value	Pounds	Value	Pounds	Value
Germany, West	531	$4,322	641	$27,827	491	$22,592
Mexico	--	--	112	2,331	--	--
U.S.S.R	11,446	200,349	7,785	157,957	2,659	58,336
United Kingdom	7	5,655	4	5,235	57	6,890
Total	11,984	210,326	8,542	193,350	3,207	87,818

[1] Includes scandium and yttrium.

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Australia.—According to the Rutile & Zircon Development Assoc., Ltd., the 1975 production of monazite by member companies was as follows, in short tons:

State	1973	1974	1975
New South Wales	1,076	1,071	1,207
Queensland	64	30	685
Western Australia	3,087	2,550	3,253
Total	4,227	3,651	5,145

The 41% increase in 1975 production over that of 1974 reflected the coming onstream of the heavy mineral sands project of Allied Eneabba Pty., Ltd. The company mine and wet concentrator were located near Eneabba, Western Australia, and a dry separation plant was planned at Meru, the port of export.[4] Reserves in the Eneabba mineral field were estimated at 220,000 tons of monazite.

Other companies with an interest in the Eneabba mineral fields in Western Australia included Jennings Mining, Ltd., which was producing heavy minerals, and Western Titanium, Ltd., and Western Mining Corp. Ltd., Mineral Sands Pty., Ltd., which have planned projects in the area. International Nickel Australia, Ltd., a subsidiary of the International Nickel Co. of Canada, Ltd., filed an application to search for monazite and other related heavy minerals in the Eneabba area.[5]

Mary Kathleen Uranium, Ltd., announced plans to construct a large-scale

[4] Skilling's Mining Review. Allied Eneabba Mineral Sands Project. V. 64, No. 35, August 1975, p. 17.

[5] Industrial Minerals. No. 94, July 1975, p. 35.

pilot plant to recover rare earths from uranium-processing operations. The rare-earth recovery plant was expected to be completed in early 1976. Commercial production is dependent upon further investigation into the economic feasibility of marketing rare-earth compounds, and was expected to begin in 2 to 3 years. It was estimated that the sales of rare earths could amount to $4 million per year.[6]

Table 4.—Monazite concentrates: World production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
Australia	4,725	4,206	[e] 5,200
Brazil	[r] 1,586	[e] 1,650	[e] 1,650
India	3,858	[e] 3,300	[e] 3,300
Korea, Republic of	10	[e] 10	[e] 10
Malaysia [2]	2,141	1,965	[e] 1,900
Mauritania	(3)	(3)	--
Nigeria	6	12	[e] 12
Sri Lanka	[e] 10	7	[e] 10
Thailand	351	486	405
United States	W	W	W
Zaire	250	261	328
Total	[r] 12,937	11,897	12,815

[e] Estimate. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] In addition to the countries listed, Indonesia and North Korea may produce monazite, but information is inadequate to make reliable estimates of output levels.
[2] Exports.
[3] Revised to zero.

Burundi.—A large vein of bastnäsite was reportedly found near the original rare-earth mining site at Gakara, about 25 miles south of Bujumbura.[7]

Canada.—Denison Mines, Ltd., reported production of 77,000 pounds of yttrium oxide contained in yttrium-rare-earth concentrate in 1975; all production was exported. This was an 11% decline in production from that in 1974, mainly a result of labor problems during 1975. Since the start of operations 17 years ago, a total of 625,000 pounds of yttrium oxide has been produced.[8]

Germany, West.—A new production process for rare-earth-cobalt alloy powders to make permanent magnets was developed by Th. Goldschmidt AG of Essen. The process was based on the calciothermic reduction of oxidic starting materials. In March, a new rare-earth alloy plant at Essen was brought into operation by Goldschmidt.[9]

India.—A monazite-sand separation plant at Gopalpur in southern Orissa was under construction by the Government-owned Indian Rare Earth, Ltd. Initial production of 4,400 tons of monazite per year, which will be a byproduct of ilmenite and rutile mining, was scheduled.[10]

India's National Institute of Oceanography conducted an extensive survey of shallow offshore areas for heavy minerals. According to the Institute, India's beaches were rich in heavy mineral placers containing ilmenite, monazite, and garnet.[11]

Japan.—A proposed expansion at the Sumitomo Special Metals Co. Yamasaki works to increase the capacity of its rare-earth-cobalt magnet plant was scheduled for spring 1976. The capacity was to be increased from 20 to 500 kilograms per month.[12]

Imports of crude rare-earth chloride declined from 2,157 tons in 1974 to 672 tons, of which 39 tons was imported from the United States. The demand for rare-earth materials declined in 1975, although specific compounds such as yttrium, europium, and lanthanum oxide for use in a ceramic condenser were in higher demand. The rare-earth compounds that declined in demand from the 1974 level were fluorides

[6] Engineering and Mining Journal. V. 176, No. 5, May 1975, p. 182.
[7] U.S. Embassy, Bujumbura, Burundi. State Department Airgram A-01, Jan. 6, 1976, p. 7.
[8] Denison Mines, Ltd. 1975 Annual Report. P. 4.
[9] Metal Bulletin. New RE-Co Powder Process. No. 6049, Dec. 12, 1975, p. 25.
[10] U.S. Embassy, New Delhi, India. State Department Airgram A-389, Dec. 17, 1975, p. 4.
[11] Engineering and Mining Journal. V. 176, No. 12, December 1975, p. 124.
[12] Metal Bulletin. No. 6047, Dec. 5, 1975, p. 25.

used in carbon arcs and the steel industry, mischmetal for the steel industry, cerium oxide for polishing optical glass, and lanthanum oxide used in optical glass.[13]

Liberia.—According to a cooperative study by the U.S. Geological Survey and the Liberian Geological Survey, Liberian coastal sands may contain sufficient monazite and other heavy minerals for profitable extraction. Analysis indicated that the monazite contained 59.9% REO.[14]

Malaysia.—Malaysian Rare Earth Corp. (MRE), a joint venture of Mitsubishi Chemical Industries Ltd. of Japan and Beh Minerals Sendirian Berhad of Ipoh, Perak State, Malaysia, was formed in February. MRE planned to produce over 11 tons per month of semiprocessed yttrium concentrate by June 1976. The source of the yttrium was the mineral xenotime, a byproduct of Malaysia's heavy-mineral mining.[15]

South Africa, Republic of.—The proposed heavy-mineral operation on the east coast, north of Richards Bay by two companies, Tisand (Pty.) Ltd. and Richards Bay Iron and Titanium (Pty.) Ltd. was scheduled to proceed as soon as financial arrangements were completed. The proposed mining area will be approximately 11 miles long by 2 miles wide. Monazite will probably be recovered as a byproduct of ilmenite, rutile and zircon mining. Output was expected to be 75,000 tons of rutile and 150,000 tons of zircon per year.[16]

Sri Lanka.—Work continued at Pulmoddai Beach by the Mineral Sands Corporation of Sri Lanka on installing the infrastructure for a mineral sands plant scheduled to come onstream by 1980.[17] The new complex will have an estimated production capacity of 500 tons of monazite per year.

United Kingdom.—Thorium Ltd., a subsidiary of Rio Tinto-Zinc Corp., Ltd., Widnes, England, reportedly stopped processing monazite as of November 1975.[18] Thorium Ltd. which was founded in 1914 to supply the United Kingdom with thorium nitrate for gas mantles, but soon expanded into production of rare-earth chemicals, planned to sell off its stocks and drop out of the rare-earth business.

TECHNOLOGY

An improved rare-earth solvent-extraction circuit was studied for upgrading the yttrium product from ion exchange barren solutions after uranium recovery. The results indicated that, by varying the flow ratios, pH, solvent concentration, and modifier, it was possible to raise the yttrium grade in the product from 30% to 60%. Possibilities were also indicated for group rare-earth separations.[19]

Refractory ceramics based on silicon nitrate powder with the addition of 10 to 20 weight-percent yttria, were under consideration as a high-temperature structural material for possible use in heat engines. These ceramics are resistant to high temperatures, oxidation, and corrosion. Thus they could allow an increase in the operational temperature of heat engines, which would produce fewer pollution-causing emissions and increase thermal efficiency.[20]

Research continued on the development of a rare-earth auto-emission-control catalyst that tolerates leaded gasoline. A typical formula for such a catalyst, which is also remarkably heat resistant, would be $(La_{0.6}Sr_{0.4})(Co_{0.9}Pb_{0.1})O_3$, where La could be another element from the lanthanum series. Another exhaust-control catalyst, which also works in the presence of leaded fuel, is being developed. Again, the catalyst was basically $LaCoO_3$, but does not contain noble metals.[21]

An oxygen-sensing device enabling automotive carburators to remain in optimum

[13] Japan Metal Journal. Demand for Rare Earths Expected to Rise. V. 6, No. 19, May 10, 1976, pp. 8–9.

[14] Rosenblum, S. Analyses and Economic Potential of Monazite in Liberia. U.S. Geol. Survey J. of Res., v. 2, No. 6, November–December 1974, pp. 689–692.

[15] Industrial Minerals. Yttrium Concentrate Joint Venture. No. 92, May 1975, p. 8.

[16] Mining Magazine. Go-Ahead Announced for South African Beach Sands Project at Richards Bay. V. 133, No. 6, December 1975, p. 421.

[17] Mining Magazine. Sri Lanka Project. V. 133, No. 6, December 1975, p. 485.

[18] Cannon, J. G. Rare-Earth Supply Ample in 1975; New Markets Promise Continued Growth. Eng. Min. J., v. 177, No. 3, March 1976, pp. 184–189.

[19] Lucas, B. H., and G. M. Ritcey. Examination of a Rare Earth Solvent-Extraction Circuit for Possible Upgrading of the Yttrium Product. Can. Min. and Met. Bull., v. 68, No. 753, January 1975, pp. 124–130.

[20] Gazza, G. E. Effect of Yttria Additions on Hot-Pressed Si_3N_4. Amer. Ceram. Soc. Bull., v. 54, No. 9, September 1975, pp. 778–781

[21] Chemical Week. V. 117, No. 11, Sept. 10, 1975, pp. 39, 42.

adjustment in relation to the air-fuel mixture was developed. The device, which uses a ceramic mixture of zirconium and yttrium oxides, generates a signal upon sensing the difference in oxygen content in exhaust and unburned air. This signal is fed into a miniprocessor that adjusts the carburetor.[22]

In magnetohydrostatic (MHS) separation, nonmagnetic particles in a magnetic medium are stratified according to their densities. Very satisfactory results can be obtained when rare-earth salts of erbium, terbium, dysprosium, and holmium are used as the medium, because of the high magnetic susceptibilities of these salts. MHS separation would be best suited to free-flowing, coarse material of a low volume and high value, such as final stages of diamond recovery, jewelers' waste, and separation of nonferrous scrap.[23] This development would provide an application for rare-earth elements that are in low demand.

Work continued on rare-earth permanent magnets. By classifying and tabulating the properties of the rare-earth elements when alloyed with cobalt, new more powerful, high-temperature resistant magnets are expected. Also, these data will enable an engineer to choose exactly the magnetic device needed for a particular job. These powerful magnets could be used in monitoring the materials in a working jet engine or a hot nuclear reactor.[24] A rotor made with rare-earth-cobalt permanent magnets was installed in a new type of servomotor. The benefits included considerable savings in copper, iron, and in the magnet weight.[25]

A diffusion coating of 96% aluminum and 4% mischmetal showed an improvement over conventional aluminum coatings. The improvements were less spalling, added service life, and resistance to sulfidation and carburization. The new coating could be used on alloys specified for chemical-processing equipment and heat-treating furnaces.[26]

Rare-earth research continued at Bureau of Mines metallurgy research laboratories on a number of projects: Using rare-earth oxides as additives in high-temperature ceramics; producing mischmetal by sodium reduction of rare-earth chloride; determining optimum composition and conditions required to fabricate mischmetal-cobalt magnets; and testing the hydrogen-absorption capacity of various rare-earth-cobalt and rare-earth-nickel alloys for possible use in fuel-storage systems.

Single crystal fibers (50 micrometers or less in diameter) of neodymium-doped yttrium-aluminum garnet (Nd:YAG) were grown using a modified zone melting technique. The fibers had similar optical properties to larger rods of Nd:YAG. The combination of the fiber dimension and the low threshold of Nd:YAG gave this material a wide range of applications, particularly in optical communications.[27]

A new class of efficient, easily prepared, rare earth-doped vitroceramics for energy transfer from infrared to visible radiation were developed. They are composed of oxides of yttrium, lanthanum, gadolinium, or lutetium plus yttrium oxide and lead fluoride and an oxide of a typical glass-forming element. Experiments demonstrated that the concentration of the rare-earth ions was mainly in the microcrystalline phase, which accounted for the higher efficiency for conversion from infrared to visible radiation. These vitroceramics could possibly be employed as glass ceramic-laser material and in display applications.[28]

Single crystals of lanthanum hexaboride (LaB_6) were reported to be better than the tungsten cathode as an electron source in common electron microscopes and scanning electron microscopes. LaB_6 crystals had higher brightness and better stability even though they were tested under conditions developed for the tungsten cathode.[29]

[22] Chemical & Engineering News. V. 53, No. 44, Nov. 3, 1975, p. 22.

[23] Andres, U. T. Potentialities of Magnetohydrostatic Separation Using Solutions of Salts of Rare Earth Elements. J. of S. African Inst. of Min. and Met., v. 76, No. 3, October 1975, pp. 113–116.

[24] Industry Week. More Powerful Ferromagnetic Materials. V. 184. No. 11, Mar. 17, 1975, p. 18.

[25] Industry Week. Emerging Technologies. A New Type of Servo Motor. V. 184, No. 11, Mar. 17, 1975, p. 20.

[26] Long, R. H., C. S. Morgan, and H. Unger. Aluminum-Rare Earth Coating Counters Corrosion Failures. Metal Prog., v. 107, No. 2, February 1975, pp. 52–53.

[27] Energy and Mineral Resources Research Institute, Iowa State University (Ames, Iowa). Single Crystal Laser Fiber. Rare-Earth Inf. Center News, v. 10, No. 3, Sept. 1, 1975, p. 1.

[28] Auzel, F., D. Pecile, and D. Morin. Rare Earth Doped Vitroceramics: New, Efficient, Blue and Green Emitting Materials for Infrared Up-Conversion. J. Electrochem. Soc., v. 122, No. 1, January 1975, pp. 101–107.

[29] Energy and Mineral Resources Research Institute, Iowa State University (Ames, Iowa), LaB. is Better. Rare-Earth Inf. Center News, v. 11, No. 1, Mar. 1, 1976, p. 2.

Rhenium

By Larry J. Alverson [1]

Domestic rhenium mine production decreased 60% in 1975. However, consumption increased by over 33% and total stocks were drawn down to meet the increase. Prices for both metal powder and compounds continued to decline. Imports of metal powder increased slightly, while imports of ammonium perrhenate declined more than 70%. Bimetallic platinum-rhenium catalysts used in petroleum refining continued to be the major use for rhenium domestically and worldwide.

Table 1.—Salient rhenium statistics
(Pounds of contained rhenium)

	1971	1972	1973	1974	1975
Mine production [e]	7,250	6,100	7,000	[r] 5,000	2,000
Consumption [e]	7,600	4,800	4,400	4,500	6,000
Imports (metal and scrap)	377	168	1,437	40	59
Imports (ammonium perrhenate) [e]	3,435	1,921	3,040	3,287	966
Stocks, Dec. 31 [e]	9,700	13,000	20,000	[r] 24,000	21,000

[e] Estimate. [r] Revised.

DOMESTIC PRODUCTION

Rhenium production, as a byproduct of molybdenite (MoS_2) from various sources, decreased in 1975 to an estimated 2,000 pounds, contained in ammonium perrhenate. Closure of Kennecott Copper Corp's. rhenium recovery operation at Garfield, Utah, for most of 1975 was the principal reason for the decrease.

M & R Refractory Metals, Inc., at its Winslow, N.J., plant, produced rhenium salts for Utah International, Inc. (UI) from MoS_2 recovered at the Island Copper mine on Vancouver Island, British Columbia. Shattuck Chemical Co., Denver, Colo., recovered rhenium salts from Arizona byproduct MoS_2 concentrate. Molycorp, Inc. recovered rhenium salts from byproduct MoS_2 concentrate from Arizona porphyry copper ores.

The domestic industry operated at about 15% of production capacity in 1975, down from about 33% in 1974 due to excess producer, consumer, and dealer stocks.

Newmont Exploration Ltd., a subsidiary of Newmont Mining Corp., discontinued work on a process to recover rhenium from San Manuel molybdenite before the patented technique was fully developed. This action was due to both technical difficulties and unfavorable economics of the current rhenium market.[2]

CONSUMPTION AND USES

Estimated 1975 rhenium consumption was about 6,000 pounds, up more than 33% from that of 1974. Over 95% was used in bimetallic platinum-rhenium catalysts used principally in producing low-lead and leadfree high-octane gasoline.

[1] Industry economist, Division of Ferrous Metals.
[2] Newmont Mining Corp. Annual Report. 1975, p. 20.

The amount of domestic and worldwide catalytic reforming capacity accounted for by platinum-rhenium catalysts continued to grow. In 1975, for the first time, reforming units employing bimetallic catalysts accounted for more capacity than those using conventional platinum catalysts. Bimetallic capacity has increased about 14% per year for the past 4 years and should continue to do so in the near future. Platinum-rhenium's share of total bimetallic capacity stands at about 60% to 70%, or about 30% to 35% of total domestic reforming capacity.

Refineries such as Hunt Oil Co.'s Tuscaloosa, Ala., plant converted some reforming capacity from conventional to platinum-rhenium catalysts during 1975. Several new catalytic reforming units came onstream in 1975 employing platinum-rhenium catalysts. One such unit was at the Memphis, Tenn., refinery of Delta Refining Co., which employed the UOP R–16E catalyst. Unit capacity is 10,000 barrels per stream day, utilizing about 150 pounds of rhenium in 50,000 pounds of catalyst.

Platinum-rhenium catalysts are also used in producing BTX (benzene, toluene, and xylenes). One example is the Standard Oil Co. of California BTX unit at El Segundo, Calif. Other units exist but account for only a small percentage of total platinum-rhenium catalysts in use.

Chevron Research Co. developed a new bimetallic platinum-rhenium reforming catalyst named Type E. The catalyst contains 0.3 weight-percent each of platinum and rhenium on an alumina carrier. Together with new developments in operating procedures, the new catalyst reportedly results in better stability (lower catalyst fouling rate), better selectivity (which results in greater yields of aromatics and hydrogen and allows lower pressure operation), and lower catalyst cost. The catalyst and processing procedures are included in a new package called Rheniforming II, which allows a decrease in reformer pressure to 125 pounds per square inch (psi). It is especially attractive for the manufacture of BTX, since BTX manufacture is enhanced by low-pressure operation. When processing a predominantly paraffinic Arabian naphtha, reforming at 125 psi gave a 14% increase in total benzene-toluene yield over the 200-psi operation. A naphthenic California feedstock showed a 7% increase in benzene-toluene yield under similar conditions. Of the 50 Rheniformer plants now in operation or under construction, 23 are specifically designed for low-pressure operation.

Since the introduction of Rheniforming catalysts in 1967, none of the units Chevron has designed have required replacement of the catalyst due to process failure. The oldest catalyst produced 750 barrels of feed per pound of catalyst, was regenerated 12 times, and returned to the condition of a fresh catalyst after each regeneration. Total Rheniforming units now in operation contain about 10,000 pounds of rhenium in catalyst and have gone through over 100 regenerations.

Chevron has combined an improved catalytic hydrocracking and catalytic reforming process to upgrade lower valued heavy petroleum stocks into higher valued lower boiling products. While manufacture of motor gasoline is emphasized, the process combination gives the refiner flexibility to take advantage of the economic potential for production of jet fuel, middle distillates, and aromatics as markets develop. The reforming phase utilizes the Chevron Type D platinum-rhenium catalyst.

Joint developments by Atlantic Richfield Co. and Engelhard Minerals & Chemicals Corp. in the catalytic reforming area resulted in the Magnaformer process design and the E–500 and E–600 series platinum-rhenium catalysts. These catalysts have been well received as replacements in existing reforming units, and for use in new units designed for these more efficient catalysts. Currently over 60 units use the E–500 and E–600 series bimetallic catalysts. Engelhard estimates that the E–601 catalyst can perform efficiently over periods about 8 times as long as the conventional platinum catalyst. It can also be regenerated to essentially new condition. Of the commercial units operating with the E–501 catalyst, three or four have undergone as many as six in situ regenerations. With the E–601 catalyst, four regenerations have been completed, and the ensuing cycles are doing very well.

The remaining 5% of estimated domestic rhenium consumption was used in high-temperature thermocouples, X-ray tubes and targets, electrical contacts, electronic devices, vacuum tube and flashbulb filaments, heating elements, metallic coatings, electromagnets, and certain high-temperature alloys in research and development work.

Rhenium's commercial use in nickel-base high-temperature alloys is uncertain. It can be utilized effectively, but researchers appear to be designing around its use, probably owing to its high price and previously limited availability. However, the current price is less than half of what it was 4 years ago, when it peaked at well over $1,000 per pound, and stocks are high.

General Electric Co. (GE) is currently working under contract on nickel-based alloys containing 3 to 6 weight-percent rhenium for use in jet engine turbine blades. Completion of the development and evaluation program is planned for 1981. However, GE has been looking for ways to develop the alloys without the addition of rhenium.

Separate research continued on similar applications with up to 2 weight-percent and less rhenium additions to a nickel-based alloy.

PRICES

The price for rhenium metal powder during the year ranged from about $625 to $540 per pound, depending upon grade and quantity, decreasing toward $540 by yearend. The price for perrhenic acid, a starting material in certain catalytic applications, ranged from about $600 to $500 per pound, depending upon grade and quantity, trending toward $500 later in the year. However, large-quantity buyers were able to purchase metal powder and rhenium compounds at greater discounts.

FOREIGN TRADE

Imports for consumption of rhenium metal, waste, and scrap increased to 59 pounds from 40 pounds in 1974. Total value was $27,196. The imported rhenium was produced in the supplying countries from molybdenite obtained as a byproduct of porphyry copper ores mined in Canada, Chile, and Peru, and from sedimentary copper ores mined in Zaire, in which molybdenum is not a factor. The average value of imports was $464 per pound, representing the fourth consecutive year that value per pound of imports declined.

Imports of ammonium perrhenate (NH_4ReO_4), decreased sharply in 1975 to an estimated 966 pounds of contained rhenium valued at $442,000. All imports came from Sweden and West Germany. In addition, ammonium perrhenate, containing 837 pounds of rhenium valued at $344,692, was imported from Chile into bonded warehouses in 1975. All ammonium perrhenate material was imported under the basket classification "Ammonium compounds, not specifically provided for (TSUS 417.44)." A minor amount of wrought rhenium metal was imported from Austria in 1975.

The import duty on rhenium from countries with market economies remained at the January 1, 1972, rates of 5% ad valorem for unwrought rhenium metal, and 9% ad valorem for wrought rhenium metal. The duty on wrought and unwrought rhenium metal from countries with centrally controlled economies also remained unchanged at 45% and 25% ad valorem, respectively. The duty on imports of ammonium perrhenate from countries with market economies was 4% ad valorem; the duty on that from countries with centrally controlled economies was 25% ad valorem. The duty on rhenium waste and scrap was suspended indefinitely.

Table 2.—U.S. imports for consumption of rhenium metal (including scrap), by country
(Gross weight, pounds)

Country	1971 Quantity	1971 Value	1972 Quantity	1972 Value	1973 Quantity	1973 Value	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Austria	--	--	--	--	--	--	--	--	1	$300
Belgium-Luxembourg	220	$262,278	--	--	110	$74,500	--	--	28	11,136
France	45	49,770	25	$23,796	--	--	--	--	--	--
Germany, West	110	140,000	143	101,955	1,116	782,497	40	$27,734	30	15,760
Netherlands	--	--	--	--	211	147,679	--	--	--	--
United Kingdom	2	794	--	--	--	--	--	--	--	--
Total	377	452,842	168	125,751	1,437	1,004,676	40	27,734	59	27,196

Table 3.—Estimated imports for consumption of ammonium perrhenate, by country [1]
(Rhenium content)

Country	1971 Quantity (pounds)	1971 Value (thousands)	1972 Quantity (pounds)	1972 Value (thousands)	1973 Quantity (pounds)	1973 Value (thousands)	1974 Quantity (pounds)	1974 Value (thousands)	1975 Quantity (pounds)	1975 Value (thousands)
Chile	--	--	76	$45	--	--	1,232	$449	--	--
Germany, West	1,395	$1,545	845	1,054	1,450	$1,913	1,520	1,185	401	$165
Sweden	2,040	2,202	1,000	1,189	1,590	1,916	535	171	565	277
Total	3,435	3,747	1,921	2,288	3,040	3,829	3,287	1,805	966	442

[1] Figures are derived from the basket category "Ammonium compounds not specifically provided for (TSUS 417.44)."

WORLD REVIEW

Canada.—The only source of Canadian rhenium production was from molybdenite concentrate associated with the porphyry copper ore from the Island Copper mine of UI on Vancouver Island, British Columbia. In 1975, shipments of molybdenite concentrate to the United States and Europe totaled about 1,750 tons and contained about 4,200 pounds of rhenium. The concentrate averaged 1,200 parts per million (ppm) of rhenium in MoS_2 and represented one of the highest concentrations of rhenium in the world. About 12,300 pounds of rhenium has been shipped from the mine since operations began in 1972; however, not all of the MoS_2 was treated for rhenium recovery. The recovered rhenium was toll-processed in Europe and the United States and returned to UI as ammonium perrhenate for subsequent sale.

Investigations of porphyry copper ore bodies in nearby areas have indicated similar concentrations of rhenium in MoS_2 associated with some of the deposits. Canadian rhenium reserves are estimated at 400,000 pounds, with the total resource estimated at 3 million pounds.

Chile.—The Chilean Mine Workers Federation offered to build a $7 million molybdenum-rhenium plant in northern Chile. The plant could process 10 million pounds of molybdenite per year and produce about $5 million worth of molybdenum oxide and rhenium annually. The Federation's 20,000 members offered to contribute 1 day's pay per month towards the project, up to $1.7 million, with the difference coming from foreign credits.

The expansion of the Chuquicamata copper operation, with expected trebling of molybdenum output and concomitant greatly increased rhenium capacity, was scheduled for completion in 1978. Feasibility studies for other potential copper-molybdenum operations with rhenium potential were continuing.

Chile exported rhenium to the United States in the form of ammoniun perrhenate; all of it went into bonded warehouses. However, these exports ceased as of June 1975.

Chilean rhenium reserves are estimated at 1.4 million pounds, with the total resource estimated at 4 million pounds. Chile remains one of the world's largest potential rhenium producers.

Germany, West.—Hermann C. Starck Company, Inc., at Goslar continued to produce rhenium from molybdenite concentrate imported primarily from Chile and Peru. Starck handled sales of its associates Gesellschaft für Elektrometallurgie mbH (which produces rhenium at Weisweiller, West Germany) and AB Ferrolegeringar (which produces rhenium at Trollhatten, Sweden). The combined production capacity for these operations is about 5,000 pounds per year.

Degussa, Inc., headquartered in Frankfurt, performed research on rhenium alloying applications and recovered rhenium from scrap material and MoS_2 concentrate.

Iran.—The Sar-Cheshmeh porphyry copper deposit in southern Iran was expected to produce 40,000 tons of ore per day in 1977. The predominant primary minerals are disseminated chalcopyrite, pyrite, and molybdenite; the ore body contains an estimated 450,000,000 tons of ore grading 1.13% copper sulfide and 0.03% molybdenite.[3] With an estimated content of 200 ppm rhenium in MoS_2 concentrate, the ore body could contain over 50,000 pounds of rhenium.

The National Iranian Oil Co. installed a 14,760-barrel-per-day reforming unit at its Teheran refinery during the year. The unit was designed by Universal Oil Products Co. (UOP) and goes under the trade name of a Unifining-Platforming combination unit. The unit employs one of UOP's bimetallic platinum-rhenium catalyst which supersedes the older platinum (monometallic) catalyst.

U.S.S.R.—Nonferrous production is oriented to the recovery of major metals, which reportedly results in the loss of a considerable amount of byproduct metals such as rhenium. The Balkhash copper complex in Kazakhstan recovers less than 50% of the rhenium in reverberatory gases and has a 15% overall recovery from the raw material. Soviet rhenium production averages over 2,000 pounds per year, most of which is consumed domestically. Total reserves are estimated at 800,000 pounds, with total resources estimated at 2.4 million pounds.

Zaire.—Although official statistics are unavailable, mine production of rhenium from Zaire averages about 200 pounds per year. The copper deposits from which the rhenium is recovered are of the sedimentary type, as opposed to the porphyry type from which about 98% of the world's rhenium is recovered. Rhenium is recovered from copper concentrate in Belgium but averages only about 10 to 30 ppm versus 200 to 1,500 ppm in MoS_2 concentrate associated with porphyry copper ores. Metallurgie Hoboken-Overpelt S.A., in Brussels, recovers the rhenium, and has capacity to produce several hundred pounds per year.

TECHNOLOGY

The Bureau of Mines published results of an investigation on the recovery and separation of molybdenum and rhenium from a process solution. The objective of the research was to develop a technique whereby reagents are recycled and high-purity products obtained. Emphasis was placed on the use of feed solutions derived by the electrooxidation of sulfide minerals. The researchers concluded that very high percentages of molybdenum and rhenium can be separated from a pregnant electrooxidation solution by a combined process utilizing solvent extraction, carbon adsorption, and crystallization. The final rhenium product, ammonium perrhenate, contained less than 80 ppm combined impurities.[4]

The Bureau of Mines completed construction and assembly of a commercial-size, 125-volt, 1,000-ampere, bipolar flow-through electrooxidation cell for recovering molybdenum and rhenium from various sulfide concentrates. The cell will be tested at the mill site of a major copper producer to determine its effectiveness for extracting molybdenum and rhenium from offgrade molybdenite concentrates. In-house tests were conducted with the cell on recovering molybdenum from electrooxidation solutions by calcium chloride precipitation. Molybdenum was recovered as calcium molybdate containing 0.02% to 0.15% sulfur. The rhenium was recovered from the solution after the calcium molybdate was

[3] Waterman, G. C., and R. L. Hamilton. The Sar Cheshmeh Porphyry Copper Deposit. Econ. Geol., v. 70, No. 3, May 1975, pp. 568–576.

[4] Fischer, D. D., D. J. Bauer, and R. E. Lindstrom. Recovery and Separation of Molybdenum and Rhenium From A Process Solution. BuMines RI 8088, 1975, 12 pp.

removed by raising solution pH to 10 by addition of sodium hydroxide, and passing the solution through a bed of a strong anion exchange resin. Rhenium recovery by this procedure ranged from 70% to 80%.

The Bureau of Mines also completed studies on chlorination of sulfide minerals and several prepared metal sulfides. The resulting data were analyzed with respect to kinetics of the reactions and application to nonpolluting methods of winning metals from sulfide ores. The researchers concluded that rhenium sulfides, depending upon their dispersion within the ore, may not react rapidly enough to be recovered; however, various complicating factors make it necessary to consider each source of ore separately when contemplating chlorination processing.[5]

The electronic properties of resistive films of rhenium and its alloys VR27–VP and MR47–VP, obtained by thermal deposition and cathodic sputtering, were studied. High temperature and prolonged use of resistors showed that films prepared by electron beam deposition and protected with a layer of SiO_2 had a negative temperature coefficient of resistance, and the relative change in the resistance after 500 hours at 400° C in air was not greater than 5% to 10%. Resistors prepared from the alloys had a somewhat lower temperature and time stability. Such resistors can be used as passive elements in microcircuits and radio devices that operate below 400° C.[6]

The development of alloys containing rhenium for electrical contacts was studied in an effort to increase the sensitivity, accuracy, and reliability of highly sensitive magnetoelectric relays and contact electronic measuring instruments. From an analysis of the requirements for the contacts, gold was selected as the base material, and rhenium gave the best alloy at less than 3% rhenium. These alloys reportedly proved better than existing alloys in their electrophysical and mechanical properties. The best gold-rhenium alloys, tested under industrial conditions, showed considerable promise.[7]

Electron-beam-melted molybdenum 47 weight-percent rhenium was strengthened by adding 0.08% to 0.10% carbon while preserving low-temperature ductility. Deformation strengthening of ternary alloys was observed during hot rolling. The recrystallization temperature increased with increasing carbon content. The alloy was also strengthened by adding zirconium carbide (ZrC). Low-temperature ductility was slightly decreased on adding 0.8% ZrC, but strength at 1,200° C was increased by a factor of two.[8]

Kennecott Copper Corp. received a patent on extracting rhenium from dilute industrial solutions. A solution (flue gas scrubbing solution, a raffinate, or dump leach liquor) is treated with iron or zinc powder to precipitate dissolved rhenium values, and also with copper or silver particles as a collector for the precipitated rhenium values. The fine precipitate is mechanically separated from the larger collector particles.[9]

A process was patented for recovering rhenium from molybdenite. Finely divided ore is contacted with an ammonium persulfate solution at 25° to 40° C so that a substantial portion of the molybdenum is dissolved along with copper and iron, whereas substantially all of the rhenium remains in the undissolved residue. The leach solution is separated and processed for molybdenum. The solids are leached to dissolve rhenium, and the rhenium is recovered by electrolysis.[10]

A patent was issued on extracting rhenium values from copper precipitates derived from solutions obtained by leaching rhenium-containing copper sulfide ore, or mine or mill wastes. The copper precipitate is slurried in a mineral acid at a

[5] Landsberg, A., A. Adams, and J. L. Schaller. Chlorination Kinetics of Selected Metal Sulfides. BuMines RI 8002, 1975, 15 pp.

[6] Kondratov, N. M., M. D. Reznikov, E. D. Yakovlev, E. M. Savitskii, M. A. Tylkina, and L. L. Zhdanova. (High-Temperature Thin Film Resistors from Rhenium and Its Alloys.) Trans. 4th Problems of Rhenium Conf., Moscow, U.S.S.R., 1973, (pub. 1975), pp. 163–165; chem. Abs., v. 83, 1975, p. 516.

[7] Chernyavskaya, A. M., E. P. Razgulyaev, and S. A. Telezhkin. (Rhenium-Containing Contact Materials.) Trans. 4th Problems of Rhenium Conf., Moscow, U.S.S.R., 1973 (pub. 1975), pp. 182–185; Chem. Abs., v. 83, 1975, p. 512.

[8] Kurdyumova, G. G., Y. V. Miloman, V. I. Trefilov, and N. I. Freze. Possibility of Strengthening a Molybdenum-Rhenium Alloy. Phys. Metals and Metallurgy (Kiev, U.S.S.R.), v. 39, No. 3, 1975, pp. 585–590; Chem Abs., v. 83, 1975, p. 382.

[9] Richards, K. J., and C. N. Wright (assigned to Kennecott Copper Corp., New York, N.Y.). Process for Recovering Rhenium Values From Dilute Solutions of Same. U.S. Pat. 3,894,866, July 15, 1975.

[10] Carlin, W. W. (assigned to PPG Industries, Inc., Pittsburgh, Pa.). Opening of Molybdenite and the Electrowinning of Rhenium. U.S. Pat. 3,891,521, June 24, 1975.

temperature of less than 100° C, the slurry is injected with air and/or oxygen to selectively oxidize and dissolve the rhenium as the perrhenate ion, and the leach solution is separated and subjected to an ion exchange treatment or other conventional method.[11]

[11] Amman, P. R. (assigned to Kennecott Copper Corp., New York, N.Y.). Recovery of Rhenium From Precipitate Copper. U.S. Pat. 3,915,690, Oct. 28, 1975.

Salt

By Russell J. Foster [1]

Salt production in 1975 was 10% less than in 1974. This amounted to a total production decline of more than 4.7 million tons. The amounts of both brine and solar salt sold or used decreased 17%. There were smaller declines in the amounts of vacuum-pan, open-pan and rock salt sold or used. Prices of all forms of salt rose in 1975. Evaporated salt prices were up significantly, whereas rock salt and salt in brine exhibited only small price increases.

A depressed chemical industry was the primary cause of reduced salt consumption. The manufacture of chlorine-caustic soda, soda ash, and other chemicals required 4.91 million tons less salt as starting material in 1975 than in 1974. The lower chemical output was affected by environmental regulations as well as a generally lagging economy. Chlorinated solvents, pesticides, and chlorofluorocarbons were under attack for possible harmful effects on the environment, and their production was reduced accordingly. Two Solvay soda ash plants, which used salt as a raw material, were closed in 1975 because of restrictions on the objectionable effluent streams from the plants and because of higher energy costs.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient salt statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Production [1]	44,700	44,010	44,298	46,423	41,710
Sold or used by producers [1]	44,077	45,022	43,910	46,536	41,030
Value	$303,687	$296,772	$306,103	$360,763	$368,063
Exports	670	869	609	521	1,332
Value	$4,182	$5,544	$4,400	$4,276	$9,070
Imports for consumption	3,855	3,463	3,207	3,358	3,215
Value	$14,429	$11,979	$12,554	$14,428	$15,272
Consumption, apparent	47,262	47,616	46,508	49,373	42,913
World: Production	159,107	161,350	r 170,483	182,102	179,109

r Revised.
[1] Excludes Puerto Rico: 28,500 short tons (1971), 29,000 short tons (1972–1974), and an estimated 27,000 short tons (1975).

DOMESTIC PRODUCTION

Total salt sold or used in 1975 was nearly 12% less than that of 1974. Declines were most notable in brine and solar salt. In 1975, there were 55 salt-producing companies operating 100 plants in 16 States and Puerto Rico. Twelve of these companies produced over 1 million tons each and thus accounted for 86% of the U.S. salt production. The five leading States in the amount of salt sold or used were as follows:

State	Percentage of total
Louisiana	29
Texas	21
New York	15
Ohio	12
Michigan	10
Total	87

Salt sold or used in 1975, by type, was as follows:

	Percent
Salt in brine	52
Mined rock salt	35
Vacuum-pan salt	8
Solar-evaporated salt	4
Grainer or open-pan salt	1

Table 2.—Salt sold or used by producers in the United States,[1] by method of recovery
(Thousand short tons and thousand dollars)

Recovery method	1974		1975	
	Quantity	Value	Quantity	Value
Evaporated:				
Bulk:				
Open pans or grainers	540	18,456	526	22,626
Vacuum pans	3,032	104,780	2,801	120,465
Solar	1,910	17,763	1,583	19,009
Pressed blocks	440	15,888	436	17,808
Total [2]	5,922	156,886	5,345	179,908
Rock:				
Bulk	14,753	105,383	14,200	104,179
Pressed blocks	82	3,308	84	3,733
Total [2]	14,835	108,692	14,283	107,912
Salt in brine (sold or used as such)	25,779	95,185	21,401	80,243
Grand total [2]	46,536	360,763	41,030	368,063

[1] Excludes Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.

Table 3.—Salt sold or used by producers in the United States
(Thousand short tons and thousand dollars)

State	1974		1975	
	Quantity	Value	Quantity	Value
Kansas [1]	1,367	27,007	1,446	31,214
Louisiana	13,543	76,960	12,166	77,116
Michigan	4,445	62,055	4,020	68,353
New Mexico	167	W	147	1,048
New York	6,464	57,705	5,978	57,344
Ohio	5,029	49,089	5,083	54,651
Texas	11,379	51,296	8,560	42,119
Utah	771	7,321	631	7,717
West Virginia	1,201	6,296	972	4,671
Other States [2]	2,169	23,035	2,026	23,830
Total [3]	46,536	360,763	41,030	368,063
Puerto Rico	29	624	[e] 27	[e] 639

[e] Estimate. W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Quantity and value of brine included with "Other States."
[2] Includes Alabama, Arizona, California, Colorado, Kansas (brine only), Nevada, North Dakota, Oklahoma, and values indicated by symbol W.
[3] Data may not add to totals shown because of independent rounding.

Table 4.—Evaporated salt sold or used by producers in the United States

(Thousand short tons and thousand dollars)

State	1974		1975	
	Quantity	Value	Quantity	Value
Kansas	778	23,127	771	26,274
Louisiana	296	11,386	275	15,112
Michigan	1,244	42,127	1,185	50,351
New York	641	21,980	579	24,595
Utah	W	W	590	7,508
Other States [1]	2,963	58,265	1,945	56,067
Total [2]	5,922	156,886	5,345	179,908
Puerto Rico	29	624	[e] 27	[e] 639

[e] Estimate. W Withheld to avoid disclosing individual company confidential data; included in "Other States."

[1] Includes Arizona, California, Nevada, New Mexico, North Dakota, Ohio, Oklahoma, Texas, and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Table 5.—Rock salt sold by producers in the United States

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1971	13,700	89,321
1972	14,434	91,041
1973	12,347	78,544
1974	14,835	108,692
1975	14,283	107,912

Table 6.—Pressed-salt blocks sold by original producers of salt in the United States

(Thousand short tons and thousand dollars)

Year	From evaporated salt		From rock salt		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1971	367	10,532	87	2,095	454	12,627
1972	376	10,927	66	2,138	442	13,065
1973	451	14,508	72	2,551	523	17,059
1974	440	15,888	82	3,308	522	19,196
1975	436	17,808	84	3,733	520	21,541

Directors of Diamond Crystal Salt Co. authorized a $2.5 million expansion and modernization program for its St. Clair, Mich., salt refinery that will increase granulated salt capacity 33% when it comes onstream in 1977. The company also planned to convert the plant back to a coal-fired boiler operation at a cost of $2.1 million.[2]

Morton Salt Co. announced a $2.8 million expansion program at its Manistee, Mich., plant to increase evaporated salt capacity 100,000 tons per year. Completion of the project was scheduled for early 1977.[3]

The water level in Utah's Great Salt Lake was expected to reach a 46-year high in 1975, making salt producers there adjust to processing a lake brine of reduced saline concentration. In addition, the high water level has forced the salt companies to heighten dikes around solar evaporating ponds.[4]

STOCKS

The total amount of salt held by producers at yearend was about 2.4 million tons, which represented 6% of 1975 production. Over 70% was in the form of rock salt and another 21% was solar salt. Solar salt had the highest percentage of its production in stocks, 32%. Rock-salt stocks were approximately 12% of the total production, while the amounts of open-pan and vacuum-pan salt production in stocks were 3.2% and 2.4%, respectively. Only a small inventory of salt in brine was on hand at yearend.

CONSUMPTION AND USES

The chlorine-caustic soda industry continued as the leading salt user in 1975, consuming 46% of the total. The amount of salt required for the production of soda ash was 11% of salt output, and the manufacture of other chemicals consumed another 2.5%. Therefore, of the salt sold or used in 1975, nearly 60% was utilized as raw material for chemicals, compared with almost 63% in 1974. The economy and environmental regulations both contributed to the significant decline in chemical production. Use of salt on highways declined slightly in 1975. However, there were localized shortages at yearend, particularly in Michigan.

Other categories in which salt consumption was down notably from 1974 included water-softener manufacturers and service companies, feed dealers, grocery stores, rubber production, and the textile and dyeing industry. Consumption of salt by most food processors was similar to that of 1974. Among those showing considerable gains in salt usage were feed mixers.

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2 Pit and Quarry. Diamond Crystal Salt to Expand St. Clair Refinery. V. 68, No. 4, October 1975, p. 20.

3 Chemical Marketing Reporter. Morton Expanding in Salt. V. 208, No. 9, Sept. 1, 1975, p. 4.

4 Chemical Week. Still Worth Its Salt? V. 117, No. 2, July 9, 1975, p. 17.

Table 7.—Distribution of salt sold or used by producers in the United States, by use
(Thousand short tons)

Consumer or use	1974				1975			
	Evaporated	Rock	Brine	Total [1]	Evaporated	Rock	Brine	Total [1]
Chlorine	338	2,215	20,527	23,080	234	2,211	16,508	18,952
Soda ash	(2)	(2)	4,563	4,563	(2)	(2)	4,492	4,492
All other chemicals	W	1,170	W	1,734	W	553	W	1,021
Textile and dyeing	143	61	--	205	109	W	W	180
Meatpackers, tanners, casing manufacturers	262	329	--	591	241	338	--	579
Dairy	65	4	--	69	63	5	--	68
Canning	174	W	W	241	165	W	W	259
Baking	W	W	--	118	W	W	--	125
Flour processors (including cereal)	73	12	(2)	85	79	21	(2)	101
Other food processing	575	W	W	614	572	W	W	611
Feed dealers	1,010	501	--	1,512	858	452	--	1,310
Feed mixers	262	209	--	471	270	283	--	552
Metals	W	203	W	252	W	229	W	265
Rubber	W	W	W	157	W	11	W	127
Oil	66	56	120	242	75	81	105	261
Paper and pulp	W	84	W	165	W	113	W	172
Water-softener manufacturers and service companies	341	W	W	835	282	W	W	586
Grocery stores	826	426	--	1,252	786	205	--	991
Highway use	W	7,451	W	7,757	W	7,439	W	7,680
U.S. Government	31	59	(2)	90	24	95	(2)	119
Distributors (brokers, wholesalers, etc.)	157	379	--	537	255	552	--	807
Miscellaneous [3]	1,568	1,439	989	[5]2,120	1,391	1,482	601	1,924
Total [1]	[4]5,893	[4]14,599	[4]26,199	[5]46,691	[4]5,403	[4]14,071	[4]21,706	[5]41,180

W Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."
[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit; included with "Miscellaneous."
[3] Includes withheld figures and some exports, and consumption in overseas areas administered by the United States.
[4] Differs from totals shown in tables 2, 4, and 5 because of changes in inventory.
[5] Differs from totals shown in tables 1–3 because of changes in inventory.

Table 8.—Distribution (shipments) of evaporated and rock salt in the United States, by destination
(Thousand short tons)

Destination	1974				1975			
	Evaporated		Rock		Evaporated		Rock	
	Domestic	Imported	Domestic	Imported	Domestic	Imported	Domestic	Imported
Alabama	54	(1)	381	--	51	--	388	--
Alaska	W	--	--	--	W	--	--	--
Arizona	35	16	3	--	34	7	4	--
Arkansas	25	--	69	--	24	--	81	--
California	1,036	127	W	--	881	141	W	(1)
Colorado	117	--	32	--	135	--	25	--
Connecticut	16	19	W	2	15	W	W	(1)
Delaware	7	30	W	2	5	5	133	W
District of Columbia	2	2	W	1	W	(1)	W	W
Florida	54	--	153	--	56	(1)	145	--
Georgia	62	--	W	(1)	60	--	229	--
Hawaii	W	--	--	--	W	(1)	--	--
Idaho	68	--	3	--	62	--	3	--
Illinois	355	3	1,073	14	358	W	1,051	W
Indiana	163	(1)	559	37	149	1	532	38
Iowa	189	(1)	341	3	177	(1)	389	W
Kansas	101	--	218	--	101	--	228	--
Kentucky	49	--	552	(1)	47	W	465	(1)
Louisiana	48	(1)	564	--	49	--	436	--
Maine	10	(1)	W	1	9	W	W	W
Maryland	67	164	58	7	47	111	57	W
Massachusetts	43	63	444	W	37	W	495	W
Michigan	212	(1)	W	630	198	(1)	W	430
Minnesota	151	5	322	50	153	(1)	415	W
Mississippi	22	--	111	--	23	--	95	--
Missouri	107	--	393	--	108	--	317	--
Montana	66	--	1	--	59	--	1	--
Nebraska	119	--	85	--	110	--	104	--
Nevada	7	9	W	--	40	1	W	--
New Hampshire	5	(1)	135	W	W	(1)	154	W
New Jersey	140	86	657	17	122	W	472	W
New Mexico	W	--	35	--	27	--	66	--
New York	320	40	1,723	83	295	38	1,571	W
North Carolina	111	20	144	(1)	94	(1)	133	(1)
North Dakota	72	--	6	1	W	--	7	(1)
Ohio	356	(1)	1,383	122	353	1	1,261	W
Oklahoma	47	--	65	--	45	--	67	--
Oregon	56	218	W	--	25	192	(1)	--
Pennsylvania	186	70	1,012	45	169	69	956	W
Rhode Island	17	1	W	--	W	W	W	W
South Carolina	47	--	16	--	43	--	13	--
South Dakota	63	--	34	--	60	--	45	--
Tennessee	124	(1)	621	(1)	120	(1)	W	(1)
Texas	193	--	245	--	152	--	394	--
Utah	252	--	W	--	175	--	W	--
Vermont	6	(1)	183	--	5	(1)	166	--
Virginia	102	23	133	(1)	80	14	130	(1)
Washington	90	655	(1)	--	60	610	(1)	--
West Virginia	24	1	130	1	19	W	180	(1)
Wisconsin	196	1	531	248	185	W	576	W
Wyoming	29	--	W	--	31	--	W	--
Other[2]	241	2	2,183	115	352	188	2,286	620
Total[3]	[4]5,893	[5]1,553	[4]14,599	[5]1,377	[4]5,403	[5]1,378	[4]14,071	[5]1,088

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1]Less than 1/2 unit.
[2]Includes shipments to overseas areas administered by the United States, Puerto Rico, exports, some shipments to unspecified destinations, and States indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.
[4]Differs from totals in tables 2, 4, and 5 because of changes in inventory.
[5]Differs from totals in tables 1 and 11-13 because of incomplete data on the distribution of imported salt.

PRICES

Salt prices quoted at yearend 1975 by Chemical Marketing Reporter, compared with yearend 1974, follow:[5]

	1974	1975
Salt, evaporated, common, 100-pound bags, carlots or trucklots, works	$1.43	$1.99
Salt, chemical-grade, same basis	1.54	2.23
Salt, rock, medium, coarse, same basis	.97	1.35
Salt, rock, extra coarse, same basis	1.02	1.40

The average value, per ton, of different classes of salt in bulk, f.o.b. works, as reported by the salt producers, was as follows:

	1974	1975
Evaporated:		
Open pans or grainers	$34.18	$43.02
Vacuum pans	34.56	43.01
Solar	9.30	12.01
Pressed blocks, all sources	36.77	41.42
Rock salt, bulk	7.14	7.34
Salt in brine	3.69	3.75

The weighted average price increase for all salt was 5%. Solar salt showed the greatest increase, 29%. The smallest rise in price occurred in brine at 1.6%. The higher prices in 1975 were due to the rising costs of labor, energy, and packaging materials. Toward yearend, two major producers, Diamond Crystal Salt Co. and Morton Salt Co., announced further price hikes of 8% to 12%.[6]

FOREIGN TRADE

In 1975, the United States imported 7.5% of its apparent consumption and exported 3.2% of its production. Canada continued to be the primary destination for U.S. salt exports, receiving nearly the entire quantity. The amount of salt exported to Canada nearly tripled in 1975. This, coupled with a 29% decrease in imports of Canadian salt, resulted in a favorable balance of trade in salt with Canada for the first time since 1955. The Bahamas replaced Canada as the principal source of imported salt with 35% of the total. An additional 32% of the salt imports came from Mexico, and 27% from Canada.

[5] Chemical Marketing Reporter. V. 206, No. 27, Dec. 30, 1974, p. 31.

[6] ———. Heavy and Agricultural Chemicals. V. 208, No. 20, Nov. 17, 1975, p. 47.

Table 9.—Salt shipped to the Commonwealth of Puerto Rico and overseas areas administered by the United States

Area	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
American Samoa	275	$16	210	$17
Puerto Rico	18,694	1,758	19,375	2,261
Virgin Islands	98	19	[1] 219	26

[1] Adjusted by the Bureau of Mines.

Table 10.—U.S. exports of salt, by country
(Thousand short tons and thousand dollars)

Destination	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Australia	1	20	(1)	11
Bahamas	2	66	2	117
Belgium-Luxembourg	1	49	(1)	4
Canada	464	2,850	1,315	7,584
Costa Rica	(1)	36	1	34
Denmark	(1)	7	(1)	23
France	(1)	15	(1)	25
Haiti	(1)	20	(1)	20
Honduras	(1)	18	(1)	17
Jamaica	(1)	13	(1)	9
Japan	2	22	(1)	33
Kuwait	(1)	10	(1)	26
Mexico	23	160	3	189
Netherlands Antilles	1	85	1	93
New Zealand	(1)	20	1	63
Panama	1	45	1	24
Peru	1	107	(1)	7
Philippines	(1)	2	1	11
Saudi Arabia	3	387	1	206
South Africa, Republic of	(1)	2	(1)	10
Sweden	(1)	9	(1)	22
Trinidad and Tobago	(1)	9	2	176
Trust Territory of the Pacific Islands	--	--	(1)	28
United Arab Emirates	(1)	28	1	102
United Kingdom	5	65	(1)	63
Other	17	231	3	173
Total	521	4,276	1,332	9,070

[1] Less than ½ unit.

Table 11.—U.S. imports for consumption of salt, by country
(Thousand short tons and thousand dollars)

Country	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Bahamas	931	3,934	1,141	5,054
Canada	1,238	6,580	[1]873	[1]4,713
Chile	79	370	28	139
Germany, West	[2]9	[2]77	(3)	120
Mexico	1,018	2,939	1,042	4,554
Netherlands	10	44	[4]8	[4]36
Netherlands Antilles	73	451	128	596
Other	(3)	33	(3 5)	[5]60
Total	3,358	14,428	3,215	15,272

[1] Includes salt brine through San Francisco customs district, 12 short tons ($449).
[2] Includes salt brine through Baltimore customs district, 8,800 short tons ($4,926).
[3] Less than ½ unit.
[4] Includes salt brine through Baltimore customs district, 11 short tons ($720).
[5] Includes salt brine from Denmark through Cleveland customs district, 3 short tons ($2,247).

Table 12.—U.S. imports for consumption of salt, by class
(Thousand short tons and thousand dollars)

Year	In bags, sacks, barrels, or other packages (dutiable)		Bulk (dutiable)	
	Quantity	Value	Quantity	Value
1973	27	559	3,180	11,995
1974	28	746	[1]3,330	r [1]13,682
1975	10	580	[2]3,205	[2]14,692

r Revised.
[1] Includes salt brine from West Germany through Baltimore customs district, 8,800 short tons ($4,926).
[2] Includes salt brine from Canada through San Francisco customs district, 12 short tons ($449); from Denmark through Cleveland customs district, 3 short tons ($2,247); and from the Netherlands through Baltimore customs district, 11 short tons ($720).

Table 13.—U.S. imports for consumption of salt, by customs district

(Thousand short tons and thousand dollars)

Customs district	1974		1975	
	Quantity	Value	Quantity	Value
Baltimore, Md	106	591	197	886
Boston, Mass	48	248	204	914
Buffalo, N.Y	40	207	64	316
Chicago, Ill	107	496	32	118
Cleveland, Ohio	96	460	65	321
Detroit, Mich	671	3,491	312	1,736
Duluth, Minn	62	431	120	621
Houston, Tex	(1)	73	(1)	104
Los Angeles, Calif	150	564	173	757
Milwaukee, Wis	247	1,281	234	1,205
New Orleans, La	11	40	10	84
New York City	202	946	234	1,202
Norfolk, Va	29	130	--	--
Ogdensburg, N.Y	10	76	24	120
Philadelphia, Pa	(1)	3	(1)	3
Portland, Me	151	682	193	906
Portland, Oreg	384	1,181	432	1,957
Providence, R.I	--	--	23	116
St. Albans, Vt	2	55	2	108
San Juan, P.R	240	971	185	746
Savannah, Ga	277	1,129	209	866
Seattle, Wash	505	1,278	428	1,847
Tampa, Fla	--	--	33	133
Wilmington, N.C	20	90	41	203
Other	(1)	5	(1)	3
Total	3,358	14,428	3,215	15,272

[1] Less than ½ unit.

Table 14.—U.S. imports for consumption of salt, by use

(Thousand short tons)

Use	1974	1975
Government (highway use)	1,354	1,160
Chemical industry	957	710
Water-conditioning service companies	194	319
Other	424	277
Total	[1]2,930	2,466

[1] Data do not add to total shown because of independent rounding. Disagreement with totals in tables 1 and 11-13 is because of incomplete data on the uses of imported salt.

WORLD REVIEW

World salt production in 1975 was estimated at 179.1 million tons. Distribution of the salt production in 1975, by continent, was as follows:

	Million tons	Percent
Europe	62.9	35
North America	56.3	31
Asia	47.0	26
Oceania	5.5	3
South America	5.0	3
Africa	2.4	1

The 12 major salt-producing nations, which together accounted for 82% of the worlds salt are listed below:

	Percent of total
United States	23
People's Republic of China	18
U.S.S.R	8
Germany, West	5
United Kingdom	5
India	4
Mexico	4
France	3
Canada	3
Australia	3
Italy	3
Romania	2

Australia, Mexico, Japan.—The governments of Australia and Mexico, two countries which together supply 90% of Japan's salt needs, raised salt prices to bring them more in line with world rates. The situation was particularly delicate because most of the Australian and Mexican salt producers are partially owned by Japanese companies with ties to Japanese buyers.

Following some months of disagreement, Japanese industry accepted a 40% increase in the price of Mexican salt. At the height of the dispute, operations were suspended at Exportadora de Sal S.A., the salt mining concession of Japan's Mitsubishi Corp. This resulted in a halt to mining operations and exportation of salt until the new price agreement was reached. In a similar move, Western Australian salt producers demanded a 33.3% price hike. Although an interim increase of 24% was agreed upon at the beginning of 1976, discussions on further price increases continued. Finally, in March 1976, the Australian Government fixed the minimum price for salt exports at the originally demanded 33.3% higher level.[7]

Canada.—Salt production was down 12% compared with 1974 production. Strikes at four locations in Canada, which resulted in a loss of 67,000 man-days, contributed significantly to the decline in productivity.[8]

Israel.—In June 1975, the Governments of the United States and Israel signed a joint agreement to construct a prototype desalting plant on the Mediterranean coast. The initial module of the Israeli-developed system will be constructed and tested by 1978. The proposed expansion of the module into the full-size, 10-million-gallon-per-day plant was scheduled for 1980.

Morocco.—A rock salt mine in the Berrechid Basin, near the Atlantic port of Mohammedia, will be the basis for construction of a new chemical complex consisting of three plants. Salt will be used as a starting material for soda ash production in one of the plants, and chlorine-caustic soda production in another. Part of the chlorine will be used in the third facility to make polyvinyl chloride.[9]

Saudi Arabia.—Two Japanese firms reached agreement with the Middle East Economic Development Co. to set up a jointly-owned venture in Jidda to manufacture and install seawater-desalination facilities. Equipment-manufacturing operations could begin by mid-1977. Initially, the company will install five desalination plants, each with a daily capacity of 5 million gallons.[10]

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[7] Business Week. Ending Japan's Squeeze on Salt Prices. No. 2409, Dec. 1, 1975, p. 32.
Chemical Age. Japan and Mexico Settle Dispute Over Salt Price. V. 112, No. 2948, Jan. 16, 1976, p. 11.
———. Australia Fixes Salt Price. V. 112, No. 2959, Apr. 2, 1976, p. 8.

[8] Mining Annual Review. June 1976, p. 295.

[9] Industrial Minerals. Rock Salt Mine and Chemical Fixing. No. 95, August 1975, p. 10.

[10] Chemical Marketing Reporter. Desalination. V. 208, No. 22, Dec. 1, 1975, p. 9.

Table 15.—Salt: World production by country
(Thousand short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Bahamas	1,236	1,132	1,359
Canada (shipments)	5,565	6,004	5,683
Costa Rica	14	15	17
Dominican Republic	43	44	[e] 44
El Salvador	39	29	[e] 25
Honduras	[e] 35	[e] 35	34
Martinique	175	[r] [e] 180	[e] 180
Mexico	4,761	6,030	[e] 7,000
Netherlands Antilles [e]	530	530	530
Nicaragua [e]	11	11	13
Panama	23	25	322
United States (including Puerto Rico):			
Rock salt	12,347	14,835	14,283
Other salt:			
United States	31,564	31,701	26,747
Puerto Rico	29	29	[e] 27
South America:			
Argentina	771	1,054	1,269
Brazil	2,044	1,711	[e] 1,650
Chile	380	263	330
Colombia:			
Rock salt	[r] 312	203	204
Other salt	[r] 1,154	761	817
Peru	333	[r] [e] 390	[e] 390
Venezuela	303	246	320
Europe:			
Albania [e]	55	55	55
Austria:			
Rock salt	1	(2)	1
Other salt	593	590	[e] 450
Bulgaria	[r] 82	143	[e] 140
Czechoslovakia	251	250	[e] 250
Denmark	406	466	269
France:			
Rock salt and brine salt	[r] 5,625	5,723	4,862
Marine salt	1,398	1,190	1,242
Germany, East	2,520	2,577	[e] 2,600
Germany, West (marketable):			
Rock salt	7,236	7,697	6,217
Marine salt and other	4,009	4,782	[e] 3,100
Greece	126	[r] [e] 130	130
Italy:			
Rock salt and brine salt	4,086	4,416	3,518
Marine salt	1,284	979	1,345
Malta	(2)	[r] [e] 1	[e] 1
Netherlands	3,355	3,734	2,965
Poland:			
Rock salt	1,389	1,549	1,7[illegible]4
Other salt	[r] 2,004	2,083	2,129
Portugal:			
Rock salt	[r] 667	684	[e] 700
Marine salt	244	246	[e] 250
Romania	3,633	4,324	4,223
Spain:			
Rock salt	[3] 1,611	[3] 1,791	[e] 1,870
Marine salt and other evaporated [4]	[r] 810	697	[e] 660
Switzerland	[r] 330	338	261
U.S.S.R. [e]	13,450	13,780	14,330
United Kingdom:			
Rock salt	[r] 1,236	1,091	992
Other salt	8,154	8,191	[e] 8,300
Yugoslavia:			
Rock salt	108	108	91
Other salt	258	249	235
Africa:			
Algeria	143	154	138
Angola	107	[e] 110	[e] 110
Dahomey	--	3	(2)
Egypt	501	549	551
Ethiopia: [5]			
Rock salt [e]	11	11	11
Marine salt	48	[e] 50	[e] 50
Ghana	118	134	84
Kenya	[r] 70	[r] [e] 70	[e] 70
Libya	[e] 11	11	[e] 11

See footnotes at end of table.

Table 15.—Salt: World production by country—Continued

(Thousand short tons)

Country [1]	1973	1974	1975 [p]
Africa—Continued			
Malagasy Republic	[e] 22	[r] [e] 10	5
Mali	6	[r] [e] 6	[e] 6
Mauritania [e]	1	1	[e] 1
Mauritius	[e] 7	6	[e] 6
Morocco	30	40	46
Mozambique	46	31	[e] 33
Niger [e]	[r] 4	2	1
Senegal	134	165	182
Somali Republic [e]	2	2	2
South Africa, Republic of	431	243	291
South-West Africa, Territory of: Marine salt	162	230	[e] 230
Sudan	83	55	73
Tanzania	42	38	49
Togo	[e] (2)	(2)	3
Tunisia	[r] 358	327	463
Uganda [e]	3	3	3
Asia:			
Afghanistan [5]	42	56	66
Bangladesh	[e] 830	187	823
Burma	188	138	[e] 154
China, People's Republic of [e]	[r] 22,000	[r] 28,000	33,000
Cyprus	[r] 8	4	7
India	[r] 7,566	6,521	[e] 7,000
Indonesia	41	77	[e] 77
Iran [5]	386	440	440
Iraq [e]	70	70	70
Israel	[r] 106	126	129
Japan	1,119	1,229	1,115
Jordan	[r] 18	17	[e] 17
Khmer Republic	34	[r] [e] 30	[e] 30
Korea, North [e]	600	600	600
Korea, Republic of	817	633	733
Kuwait	11	14	[e] 15
Laos	10	11	[e] 10
Lebanon [e]	[r] 40	39	39
Mongolia	12	[e] 12	[e] 12
Pakistan:			
Rock salt	417	432	451
Other salt	112	148	[e] 165
Philippines	243	236	78
Ryukyu Islands [e]	6	6	6
Sri Lanka	136	133	131
Syrian Arab Republic	39	44	[e] 44
Taiwan	[r] 425	406	296
Thailand [e]	180	180	180
Turkey	980	1,007	816
Vietnam, North [e]	165	165	165
Vietnam, South	220	[e] 220	[e] 220
Yemen, People's Democratic Republic of [e]	83	83	83
Oceania:			
Australia [6]	[r] 4,537	5,440	[e] 5,500
New Zealand	112	60	44
Total	[r] 170,483	182,102	179,109

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Salt is produced in many other countries, but quantities are relatively insignificant or reliable data are not available.

[2] Less than ½ unit.

[3] Series revised to include byproduct output from potash works, not previously included.

[4] Includes an average annual production in the Canary Islands of about 13,000 short tons of marine salt.

[5] Year beginning March 21 of that stated.

[6] Excludes Victoria.

TECHNOLOGY

In 1973, the Atomic Energy Commission, now part of the Energy Research and Development Administration (ERDA), intended to bury the waste from atomic powerplants in a Kansas salt mine, but political and environmentalist opposition prompted a retreat from that position. Recently, ERDA abandoned the alternate plan to store the waste in tanks above ground, thus reviving the idea of burying it in deep salt caverns. As a result, ERDA was considering a deep salt mine in New Mexico as a possible waste burial site.[11]

Shell Oil Co. completed an expansion program that added two underground salt dome cavities at its Sorrento storage facility in southern Louisiana. These two new cavities plus two old ones are used to store hydrocarbons, and have a total capacity of approximately 3.5 million barrels.[12]

Test operations of a 3-million-gallon-per-day experimental desalting plant were begun at Fountain Valley, Calif., by the Office of Water Research and Technology, U.S. Department of the Interior, in partnership with the Orange County Water District. The best features of two commercial distillation processes, vertical-tube evaporation and multistage flash-distillation, have been combined into a single concept. Engineering studies indicate that the new system required less capital investment, provided improved operation, and produced lower cost product water than either of the two processes operating independently.

Great Lakes Paper Co., Ltd., Ontario, Canada, announced plans to implement a salt recovery process to eliminate salt pollution at a new pulp mill. The process reportedly can remove sodium chloride contamination from all sources by evaporating white liquor, at lower capital and operating costs relative to external effluent-treatment processes.[13]

A solar pond, in which the sun's radiation is trapped by a heavy salt deposit on the pond's bottom and a black plastic lining, was demonstrated in Columbus, Ohio. The heated water is prevented from rising to the surface and being cooled, as it would in regular ponds, by the dissolved salt. Collected heat is stored both in the heated water and the heated soil underneath. Fresh water circulating through coils of plastic hose at the pond's bottom furnishes heat to the desired location.[14]

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[11] Washington Post. Atomic Waste Storage Plan Is Abandoned. Apr. 11, 1975, p. A-1.

[12] Chemical Marketing Reporter. Shell Opens Salt Domes for Light Ends, Ethylene at Site in Sorrento, La. V. 208, No. 24, Dec. 15, 1975, p. 5.

[13] ———. Salt Recovery Process Slated for Paper Mill. V. 208, No. 10, Sept. 8, 1975, p. 22.

[14] Columbus Dispatch. Solar Pond Functional, Popular. Sept. 26, 1975.
Chemtech. Solar Ponds for Space Heating. V. 5, No. 10, October 1975, p. 608.

Sand and Gravel

By Walter Pajalich [1]

In 1975, sand and gravel production, including industrial sand and gravel, decreased about 13% to 789 million short tons, valued at $1.4 billion. The value of sand and gravel used as construction aggregate decreased less than one-half percent in 1975.

About 97% of the sand and gravel produced was used as construction aggregate, and about 3% was used as industrial sand and gravel. Of the total construction aggregate, about 89% was produced by commercial operators and 11% by Government-operated pits with their own crews and equipment for use on publicly funded projects. Of the total construction aggregate, about 69% was used commercially and about 31% was used for publicly funded projects.

[1] Mining engineer, Division of Nonmetallic Minerals.

Table 1.—Salient sand and gravel statistics in the United States [1] [2]
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
Production:					
Processed:					
Sand:					
Quantity	327,947	330,384	346,996	322,607	265,404
Value [3]	$398,469	$418,050	$472,292	r $490,718	$448,583
Gravel:					
Quantity	483,748	461,925	510,031	404,411	353,652
Value [3]	$608,847	$607,263	$706,329	r $683,408	$634,931
Unprocessed:					
Sand and gravel:					
Quantity	81,740	92,485	97,627	r 148,558	143,097
Value	$50,286	$63,002	$70,684	r $104,205	$106,827
Industrial:					
Sand:					
Quantity	26,161	29,530	28,974	28,024	26,723
Value	$91,371	$112,386	$110,065	$135,357	$146,982
Gravel:					
Quantity	--	--	--	1,046	560
Value	--	--	--	$3,342	$2,996
Total: [4]					
Quantity	919,593	914,324	983,629	r 904,646	789,436
Value [3]	$1,148,969	$1,200,701	$1,359,370	r $1,417,030	$1,340,319
Imports:					
Quantity	715	761	800	394	374
Value	$1,228	$1,379	$1,576	$839	$777
Exports:					
Quantity	1,728	1,821	1,744	2,256	3,219
Value	$6,745	$7,178	$8,597	$11,664	$15,047

r Revised.
[1] Puerto Rico excluded from all sand and gravel statistics.
[2] Data for 1973-75 not directly comparable with those of years prior to 1973 because of increase in industry coverage (1973, 1974) and change in canvass form (1974).
[3] Value f.o.b. plant of processed sand and of processed gravel. Value in all other tables are f.o.b. plant of blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.
[4] Data may not add to totals shown because of independent rounding.

In 1974, Alaska sand and gravel production was reported as 117 million tons, of which a preliminary figure of about 100 million tons was reportedly used in the construction of the oil pipeline. The final sand and gravel production and consumption figure for the oil pipeline, as reported by the Bureau of Land Management for 1974, was 30 million tons, and about 13 million tons was produced by the remainder of the State's construction industry. Based on these new data, total U.S. sand and gravel production in 1974 was 905 million tons. In 1975, Alaska produced 48 million tons, of which about 41 million was consumed in the construction of the oil pipeline. Most of this was unprocessed sand and gravel sold by the Bureau of Land Management from Federal lands.

Of the 7,014 sand and gravel operations, 5,609 had processing plants associated with their land or dredging operations; 1,405 operations had no processing plant and the material was sold as mined. Some of the 5,609 operations have more than one plant on location for processing mined material from a single pit.

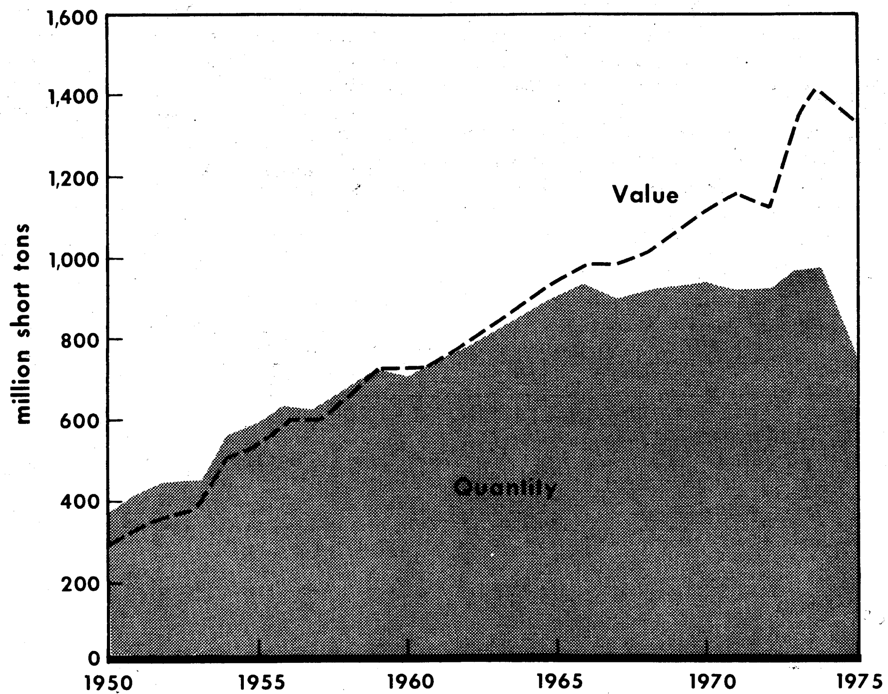

Figure 1.—Production and value of sand and gravel in the United States.

There were 5,871 construction sand and gravel operations with a production under 200,000 tons per year. These operations accounted for 42% of the total U.S. production. There were 689 operations with production between 200,000 and 500,000 tons; these accounted for 30% of the production. The remaining 239 operations, with production over 500,000 tons, accounted for 28% of the production.

There were 123 operations in the United States that produced only industrial sand and gravel and accounted for 23 million tons, or 83% of the U.S. industrial sand and gravel production. All of these had processing plants associated with the operation. Of these there were 111 operations with production of under 500,000 tons per year. There were 92 construction sand and gravel operations that produced some industrial sand and gravel. These accounted for 21 million tons of sand and gravel; of this, 4.5 million tons was industrial sand and gravel, or 17% of U.S. industrial sand and gravel production.

DOMESTIC PRODUCTION

In 1975, California with reported sales of 88 million tons of sand and gravel ranked first in the Nation. Alaska was second with production of 48 million tons. Michigan ranked third. Other States producing substantial quantities of sand and gravel, in descending order of production, were Illinois, Texas, Ohio, Minnesota, and Wisconsin. Combined, the eight leading States accounted for 362 million tons, about 46% of the total U.S. output. The value of the sand and gravel in these eight States was $592 million, 42% of the Nation's total.

The number of active commercial and noncommercial and industrial sand and gravel operations increased from 6,967 in 1974 to 7,014 in 1975. The active commercial and industrial sand and gravel operations were owned by 4,075 companies. The 679 active noncommercial operations were primarily worked by city, county, or State highway departments. An additional 834 operations reported that they were inactive during the year, and 920 operations were closed down. Sand and gravel operations opened up for use in the construction of the oil pipeline in Alaska are not included in these data.

Water and waste data in table 13 include construction and industrial sand and gravel operations. Reported amounts of water and waste generated depended upon the method of mining and type of operation. Deposits mined by dredges or below the water table and industrial sand and gravel operations generally reported higher amounts of processing water and generation of waste.

Sand and gravel information relative to the construction of the Alaska oil pipeline was left out of tables 9, 11, 12, and 13 because of uncertainty of data.

Wedron Silica Co., a division of Del Monte Properties Co., operated seven plants located at Emmett, Idaho, Cleburn, Tex., Sewanee, Tenn., Lugoff, S.C., Troy Grove, Ill., Wedron, Ill. and Byron, Calif. The operation at Byron, located about 26 miles from Stockton, is unique. The sand being mined from this deposit contains nearly the optimum amount of alumina (Al_2O_3) in the form of feldspar that is normally added by glass bottle manufacturers prior to melting and blowing. This natural composition of the sand makes it highly acceptable to the market after processing for removal of other deleterious minerals. Another prime factor is the manner in which the Byron plant processes the product, largely with specially designed or modified equipment. The operation displays considerable variance in plant layout and flow from conventional methods of washing, grading, and drying sand.

Like many other areas of the United States, Hawaii is having problems with its supply of good aggregates. This is particularly true on the island of Oahu, where most of the industry and population is located and most of the building is being done. Although there is an abundant supply of basaltic rock, there is very little natural sand available to blend with manufactured basalt sand to get the desired gradation. Digging beach sand on Oahu is illegal. Pacific Concrete & Rock Co., Ltd., of Honolulu was the first to develop coral limestone sand as a replacement for beach sand. The deposit is located at Waimanalo, 20 miles northeast of Honolulu on the island of Oahu. The deposit is a lithified oolitic limestone which includes a high percentage of sand. Following some drilling, blasting, and processing, the sand product is better in quality and more uniform in gradation than the beach sand.

In Louisiana gravel shortages have delayed construction and increased costs for current road projects totaling 1,700 miles. Until recently, gravel could be obtained close to most construction sites, but it is now being hauled increasingly longer distances at a cost of both time and money. Northwestern Louisiana projects are obtaining gravel from Arkansas, and centrally located projects are obtaining it from one of the few remaining large deposits in the State. The State Highway Director predicts the gravel will all be used up in a few years.

Contee Sand & Gravel Co., Inc., of Laurel, Md., has been sold to Boykin Resources, Inc., of Washington, D.C., for more than $30 million. Contee operates four sand and gravel plants, five ready-mix concrete plants, and a stone quarry.[2]

The North Dakota Multnomah County Planning Commission adopted and recommended to the county commissioners,

[2] Rock Products. V. 77, No. 5, May 1974, p. 138.

which passed it, a mineral extraction ordinance which sets regulations for mining sand, gravel, rock, and earthen materials in the county. The ordinance provides that mining may be permitted in any district where the Planning Commission finds that an economic deposit of the resource can be shown to exist.

The Connecticut Department of Environmental Protection (DEP) has recognized the need to plan for sand and gravel mining land use. An article on "Planning for Sand and Gravel Mining," which appeared in the DEP Citizens' Bulletin, advocated sequential land use of sand and gravel mining sites, and protection of aggregate resources from preemptive land use until the aggregate materials can be recovered and utilized.

Pennsylvania Glass Sand Corp., a subsidiary of International Telephone and Telegraph Corp., opened a new automated glass sand plant 5 miles north of Mill Creek, Johnson County, Okla. The plant, with a capacity of 750,000 tons per year, will supply molding, Hydrafrac, and glass sand for new float glass manufacturing operations of Pennsylvania Glass Sand in Wichita Falls, Tex. The company has also begun the second phase of a $2.5 million expansion at its silica plant operation near Cayce, S.C.

Shipments are expected to begin soon from the new industrial sand plant of Georgia Marble Co. at Junction City near Columbus, Ga. The high-quality product will be marketed for a full range of industrial uses such as glass, filtration, blasting, and molding sand. Processing methods include preliminary washing and screening, desliming, attrition scrubbing, flotation, drying, and sizing. Glass sand will be shipped in bulk, and other grades will be available in bulk or bagged. The water used is impounded and recycled, with no release of water to the surface drainage.

The California Department of Transportation has planned to stop calling for bids on new highway construction for a year starting July 1, because it lacked the revenue needed to match Federal funds. Federal matching funds contribute over $400 million to the State's annual revenue.[3]

Construction Aggregates Corp.'s gravel plant on the Grand River, at Ferrysburg, Mich., one of the largest shippers of gravel has drastically curtailed production due to economic conditions. Normally 100 lake freighters are loaded per season; sand is shipped to customers such as the auto industry, and gravel products to the construction industry. As poor economic conditions continued, customers were served from existing stockpiles. Normal production of the processing plant is about 500 tons per hour. Each freighter is self-loading and takes 8 to 10 hours to load.[4]

The Sully-Miller Contracting Co. of Long Beach, Calif., purchased from The Flintkote Co. the assets of Flintkote's Western Concrete Materials Division located in southern California. Included in the sale are several ready-mixed concrete and aggregate operations in Los Angeles, Orange, San Bernardino and Riverside Counties.[5]

Fountain Sand & Gravel Co., of Bloomfield, N. Mex., acquired 180 acres of aggregate deposits south of Farmington, N. Mex.[6]

Oglebay Norton Co. acquired the silica sand operations in Texas and California of Chemical Express Co., Dallas, Tex., for $2.9 million. The operations acquired were the silica sand reserves and a processing plant near Brady, Tex. This operation is one of the main suppliers of fracture sand to the petroleum industry and the principal supplier to the company's grinding and processing plant near Riverside, Calif., which produces silica flour.

CONSUMPTION AND USES

In 1975, U.S. consumption of sand and gravel amounted to 789 million tons valued at $1.4 billion. The construction industry, the prime user of sand and gravel, consumed 97% of the tonnage, representing 89% of the value of the sand and gravel output in 1975. Of the sand and gravel consumed by the construction industry as concrete aggregate, 25% went into nonresidential and residential construction, 9% into highways and bridge construction, 7% into concrete products, and 2% into

[3] Engineering News-Record. V. 194, No. 26, June 26, 1975, p. 13.
[4] The Grand Rapids Press. V. 83, No. 360, Sept. 7, 1975.
[5] Pit & Quarry. V. 67, No. 9, March 1975, p. 18.
[6] Rock Products. Rock Newscope. V. 78, No. 2, February 1975, p. 18.

other uses. Bituminous paving consumed another 15%, roadbase and subbase 16%, fill 5%, and other consumption 2%. The remaining 19% was used as unprocessed sand and gravel; 9% as fill, 9% as roadbase and subbase, and 1% as other consumption.

PRICES

Representative carlot prices, f.o.b. point of delivery of sand in 19 cities at yearend 1975 ranged from $1.35 per ton in Detroit to $6.95 per ton in St. Louis, according to the Engineering News-Record.[7] The average of the sand prices reported was $4.15 per ton, compared with $3.05 per ton in 1974. Prices for either ¾- or 1½-inch gravel ranged from $1.90 per ton in Baltimore to $7.50 per ton in Kansas City. The average of the ¾-inch gravel prices reported for 19 cities was $4.61 per ton, compared with $3.55 per ton in 1974. For 1½-inch gravel, the average for 16 cities was $4.45 per ton, compared with $3.52 per ton in 1974.

Based on the Bureau of Mines canvass, the average value of processed sand and gravel sold or used as construction aggregate by producers, f.o.b. plant, was $1.88 per ton; value of unprocessed sand and gravel was $0.75, and value of industrial sand and gravel was $5.50 per ton. The overall average value of sand and gravel was $1.79 compared with $1.57 in 1974. Unit price of construction sand and gravel is based on the value of blended sand and gravel sold or used as construction aggregate. The estimated price for processed sand and gravel used for the Alaska pipeline ranged from $0.25 to $0.56 per ton versus $0.25 to $0.35 per ton for unprocessed. The quantity and value of Alaska sand and gravel production were included in determining the above national average prices.

FOREIGN TRADE

The United States exports gravel, construction sand and gravel, and industrial sand. Gravel exports in 1975 totaled 537,290 tons valued at $863,821; construction sand and gravel, 510,859 tons, valued at $1,111,410; and industrial sand, 2,171,109 tons valued at $13,071,346. Canada received 94% of the gravel, and Mexico 5%, and the remainder was shipped to 20 different countries. Canada received 95% of the construction sand and gravel and the Bahamas 4%, and the remainder was shipped to 14 different countries. Canada received 80% of industrial sand, Mexico received 15%, and the remainder was shipped to 63 other countries.

Of the 329,475 tons of crude sand and gravel imported in 1975, almost 100% was from Canada. Of the 44,887 tons of imported glass sand, 94% was from Australia, 4% from the Republic of South Africa, and the rest from six other countries.

WORLD REVIEW

West Germany.—The Kieler Institute in West Germany estimated a 4.6% annual growth rate for the foundry industry for the next decade. West Germany's high rate of growth between 1950 and 1968 was caused by the aftermath of World War II. Future rates will be more comparable with those of other industrial economies. As the rate of industrial growth slows, increased governmental investment may be anticipated to balance the situation. Output will come from fewer firms. Currently 8 to 12 tons of sand are needed for every ton of good castings produced. Because sand must be shaped by ramming, squeezing, or vibration and because of the high investment cost of the equipment involved, foundrymen will be looking for methods of mold production which increase capacity while reducing the length of the production cycle. The active elements in molding are likely to be increasingly chemical rather than mechanical. The trend is toward machines that will eliminate the need for binders and toward successful recycling of molding sands.[8]

[7] Engineering News-Record. V. 195, No. 23, Dec. 4, 1975, pp. 24–25.

[8] Britt, H.-P., and K. Feller. The Foundry of 1999. Foundry Management and Technol., v. 103, No. 8, August 1975, pp. 32–39.

United Kingdom.—A report by the Standing Conference on London and South East Regional Planning dealt with the development of additional rail depots in southeast England for the reception of aggregates. Aggregates from other parts of the country would ease the demand from existing operations in the region, and would reduce aggregate movements by road. The present rail movements within the South East Region are entirely sand and gravel, while imports from outside the region are predominantly crushed stone. In 1973, in Great Britain as a whole, the average distance rail haul was 104 miles for crushed stone and 44 miles for sand and gravel. Present rail movements of crushed stone in Great Britain account for 5.4% of total aggregate movement and sand and gravel account for 3.4%. By 1980 the British Quarrying and Slag Federation forecast that crushed stone movement by rail will be 1.9% and sand and gravel 8.3%.[9]

Harleyford Aggregates have replaced their riverside operation in Totnes, Devon, with a new plant. The new plant has an improved sand recovery system, lower power and water requirement, and more efficient use of manpower.[10]

Corey Sand & Ballast Co., Ltd., has commissioned the construction of a new washing and grading plant at Barling, Essex. The plant will replace an old one and is expected to produce 60 tons per hour of product. Total cost including site roads is about $400,000. Blending units will be incorporated in the plant and will operate from a panel in the control room.[11]

Tilling Construction Services, Ltd., finished construction of a large new facility for supplying aggregates to northeast England. This marine aggregate terminal at Howdon, Wallsend-on-Tyne, is centrally located with an excellent network of roads for marketing. It was built on a 3-acre site at a cost of about $1 million and can handle 500,000 tons per year. The terminal can accommodate the largest sand and gravel dredge in Europe. The vessel is over 350 feet long and incorporates its own cargo offloading facilities. It can discharge at a rate of 2,000 tons per hour using its own automatic grab gantry and conveyor system.[12]

TECHNOLOGY

Memphis Stone & Gravel Co.'s new Duke washing plant, located northwest of Arlington, Tenn., incorporates many innovative applications of automation. The plant, rated at 750 tons per hour of input capacity, can be operated by a crew of seven including the plant superintendent. The plant consists of two stages, a primary and finishing stage. Material flow through each stage is controlled by an automatic remote control system monitored by an operator from the centrally located master control tower. The master control console provides control of material flow for each stage independently. This independent control of either processing stage allows for complete stoppage during emergencies or repairs of one stage without disrupting production from the other stage. The primary stage, with a greater capacity than the finishing stage, provides material for the surge pile from which the finishing stage is fed. If there are delays, stoppages at the pit, or equipment repairs, the primary stage can be shut down while the finishing stage is supplied material from the surge pile, and the primary stage can feed the surge pile if the finishing stage is shut down.[13]

Transportation and handling costs are becoming a major concern to those companies that are forced to seek new sources of sand and gravel at considerable distance from their marketing area. As Western Paving and Construction Co.'s supply of sand and gravel near Denver became depleted, plans were made to develop 300 acres of land located 43 miles north of Denver that contain a 10- to 20-foot layer of sand and gravel. After considerable planning and comparing transportation advantages of truck versus train, the decision was made to use a unit train rail transport system. To supply 3,000 tons of sand and gravel to the company asphalt

[9] Quarry Management and Products. The Development of Rail-Served Aggregate Depots. V. 2, No. 8, August 1975, pp. 197–200.
[10] ———. V. 2, No. 9, September 1975, p. 242.
[11] ———. V. 2, No. 9, September 1975, p. 246.
[12] ———. V. 2, No. 9, September 1975, pp 238–240.
[13] Leverette, F. New Duke Wash Plant Rated at 750 Tph With Minimum Crew. Pit & Quarry, v. 68, No. 1, July 1975, pp. 58–62.

plants in Denver would have taken 30 trucks operating 9 hours per day, using 2,000 gallons of fuel. For about equal capital expenditure, 30 heavy-duty rapid-discharge rail cars can deliver the same amount of aggregate in 5 hours using only 400 gallons of fuel. Also, operating costs, maintenance, and personnel are lower for the unit train.

Each morning the 30-car unit train is picked up in Denver by 3 1,750-horsepower diesel locomotive with 4 crewmen including the engineer. The 43-mile trip takes about 2 hours. On arrival the cars are pulled directly beneath six silos. The engineer and conductor, communicating by radio with the silo operator, spot cars for loading. The return trip to Denver takes about 2½ hours. A complete unmanned automatic system is used to dump the cars quickly and cleanly as the ¼-mile train moves across a trestle at 1 mile per hour. In less than 15 minutes the entire train of 30 cars can be unloaded and the cargo ready for processing.[14]

The Minnesota State Department of Highways is using about 53,000 tons of taconite tailings in the improvement of State highways. The tailings are used as aggregate in the hot plant bituminous mix applied in resurfacing bridge decks and highways. Because of the gritty texture and the high quantity of silica, the tailings-bituminous mix is of particular value in restoring the skid-resistant surface of the roads. In contract road construction, the use of tailings is optional and depends upon whether the contractor can obtain a supply of tailings and if they can be shipped more economically than conventional aggregates.

Under an agreement with the Federal Highway Administration, the Ohio Department of Transportation will evaluate the Gussasphalt membrane placed as a protective surface on a concrete bridge deck. The object of this project and those in the past has been to demonstrate the practicality and cost effectiveness of mastic asphalt systems such as Gussasphalt in the United States. Gussasphalt is a German-originated mastic asphaltic compound, which has been successfully used on more than 1,500 miles of major highways in West Germany, and in other European locations, for more than 15 years. The higher cost of this material versus U.S. asphalt pavement reputedly is compensated for by longer life, low maintenance costs, and the ability to carry traffic as soon as it cools. It can be laid in subfreezing temperatures and is highly skid resistant. The compound embodies native lake asphalt, which holds colloidal material in suspension, a property not present in petroleum asphalt. The Gussasphalt used in Ohio consisted of 9.9% bitumen, 39.7% coarse aggregate, 29.7% fine aggregate, and 20.7% mineral filler. Filler can be any inert rock product finer than 200 mesh. The bitumen was a mixture of 80% AC 40 to 50 and 20% Trinidad Lake asphalt.[15]

Exacting specifications for aggregates have increased the need to beneficiate sand and gravel. The glacial sand and gravel deposits in the north-central United States contain chert, and many of the States in this area are specifying limits on the amount of chert in concrete aggregates. Garland Manufacturing Co. of Minnesota has developed a jig that separates lightweight chert from quality sand and gravel. The jig consists of a submerged screen box which has a forward-upward stroke of 3¼ inches and back again at about 70 stroke cycles per minute. The motion of the screen underwater causes the lightweight material to rise to the top of the bed, at the same time moving it towards the discharge end. Across the discharge end of the screen is a suction manifold similar to a vacuum cleaner, but using water in place of air. The suction is created by the water flowing out of the jig tank through the manifold and the suction tubes, which are also the chert discharge tubes. Using the Garland jig, F. Radant & Sons, Inc., of Manitowoc, Wis., in the operation of their 200-ton-per-hour sand and gravel operation, reduced the amount of chert from 4% to less than ½% in ¾-inch gravel.[16]

Scientists from the University of Southern California have been conducting studies of the sand and gravel deposits off the California coast. The first area of study is the land from Point Conception to Tijuana, Mexico, for the compilation of surface sedimentological data to determine where to start looking for major offshore

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[14] Graham, F. M., Jr. Unit Train Solves Aggregate Supply Problem for Denver Firm. Pit & Quarry, v. 68, No. 5, November 1975, pp. 58–62.

[15] Road & Streets. Regular Spread Places Gussasphalt Bridge Deck. V. 118, No. 8, August 1975, pp. 27–28.

[16] Roads & Streets. Compact Washer Upgrades Gravel. V. 118, No. 12, December 1975, p. 33.

sand and gravel deposits, and for profiling studies to determine the volume of minable sediments. This first phase of the studies started in September 1974 and ended in August 1975. The second phase, September 1975 to August 1976, will involve taking vibracore samples and will attempt to identify potential sites for mining sand and gravel. The third phase, September 1976 to August 1977 will involve determination of anticipated costs of mining, the best system of mining, and assessment of environmental impact and the development of guidelines for environmental reports.[17]

Conventional asphalt paving materials containing graded, good-quality aggregate have adequate strength for use on all types of roads. When substandard aggregates are used with asphalt alone, the resultant paving materials are not sufficiently strong for use on heavily traveled roads. However, when sulfur is added with these low-quality aggregates it increases the strength of the pavement up to or above that obtained with higher quality aggregates. In many areas high-quality aggregates suitable for road paving are scarce and must be transported from distant locations at considerable cost. Low-quality aggregates are often readily available locally. Under these conditions use of sulfur in paving materials can permit utilization of lower quality aggregates at considerable savings. Using this technology, typical paving materials consist of 13% to 15% sulfur, 6% asphalt, and 80% substandard sand and gravel. The primary participants in the sulfur-asphalt-sand pavement development program include Shell Canada Ltd., U.S. Bureau of Mines, U.S. Department of Transportation, Texas A & M Research Foundation, Texas State Department of Highways and Public Transportation, Louisiana Department of Highways, Barber-Green Co., and The Sulphur Institute.

For the past 10 years the Bureau of Mines has been actively involved in developing processes for recycling materials of value contained in incinerated and raw unburned urban refuse. The glass fraction from the Bureau incinerator residue pilot plant is a sandlike product of mixed color ranging in size from minus 20 to plus 150 mesh. The Bureau has developed methods for producing bricks, glass wool, floor tile, glass reflecting beads, and lightweight aggregate. Additional research at the University of Missouri was successful in utilizing rough glass concentrates from the Bureau's pilot plant in "glasphalt" paving material. The Bureau's process for reclaiming materials from raw refuse has been patented, and licensing is available to municipalities, industry, or individuals. The process, which involves shredding, magnetic separation, air classification, trommeling, jigging, and flotation, produces a concentrate essentially identical to that obtained from incinerator residue. The uses for this product are the same as those of incinerated residue. This technology is being installed on a commercial scale in Monroe County, N.Y., and Baltimore County, Md.

The Monsanto Research Corp., working under a Federal Highway Administration research contract, has developed a unique method for producing a waterproof concrete. Portland cement concrete is mixed with 3% by weight of 20- to 80-mesh montan and paraffin wax beads. After the concrete is placed and cured, it is heated to 185° F to melt the wax beads. A portion of the melted wax is taken up by the pores and capillaries in the concrete; upon cooling, it plugs these avenues against water or salt penetration, thereby producing a waterproof concrete. At its present stage of development, the process is considered ready for limited experimental application. The estimated material cost for concrete containing the wax is about double that of ordinary concrete. If two-course construction were used on a bridge deck and the wax were added only to the top 2-inch course, the added material costs would be about $2 per square yard of surface.[18]

Contractors realining a highway south of Los Angeles are mixing almost 200,000 cubic yards of rubbish with soil to construct embankments for the new route. Specifications by the California Department of Transportation, whose idea it was to use trash as fill, call for mixing the rubbish with soil in a one-to-one basis. Each layer of mix must be covered with solid soil. Although preparations were made to spray the area with odor-masking chemicals, only initial cuts produced any foul odors. When

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[17] World Dredging & Marine Construction. Scientists Study Offshore Sand, Gravel Deposits. V. 11, No. 6, May 1975, p. 25.

[18] Federal Highway Administration, Offices of Research and Development. Newsletter. Issue 1, April 1975, pp. 1, 4.

the rubbish is dumped, a bulldozer pulling a sheepsfoot roller spreads and mixes it. The site is expected to settle normally for several years. The base will be a combination of a 9-inch-thick layer of aggregate atop slightly more than 1 foot of aggregate subbase. The wearing surface will be about 5 inches of asphaltic concrete.[19]

One of the more unique sand and gravel operations with unusual mining techniques is in the Queen Mary Reservoir at Laleham near Staines, England. In the early 1920's, the reservoir embankments enclosed over 700 acres of gravel reserve. At present almost 450 acres of the reservoir are being excavated by floating dredges without impairing the operation of the reservoir by the Thames Water Authority. The project, which is operated by a consortium of local gravel companies under the name of Reservoir Aggregates, not only produces 600,000 tons of gravel per year but also will add 1,500 million gallons to the original 6,750-million-gallon reservoir capacity. Since the dredge operator cannot see the land where he digs, which is 40 feet under water, sounding devices record the depth of excavation. A laser beam enables accurate positioning of the dredges. Because of strong winds and high waves, 300-ton self-powered bottom dump barges have been built to match these conditions so that they can reliably carry the gravel to underwater stockpiles. A recovery dredge loads the gravel from these stockpiles onto a floating conveyor link to the processing plant.

A clam dredge was selected after tests had shown that other types of dredging equipment would raise the density of fine particles in suspension to a level greater than the Water Authority would permit. German dredging equipment manufactured by Mohr & Federhaff was chosen; a 5.5-cubic-yard bucket for the digging and a 7.8-cubic-meter bucket for the stockpile reclamation. All design and operations take into account the paramount need to protect the safety of the reservoir and the water it holds. Special provisions have been made for fueling the barges and dredges, and only certain lubricants are permitted. The Water Authority has power of approval or rejection over all machinery and materials brought into the reservoir and can even require blood tests of the employees.[20]

In the beneficiation of silica sand containing kaolin, and iron in carbonate form, crude silica sand is washed or deslimed in a centrifuge to remove kaolin. The centrifuge cyclone underflow is adjusted to a pH value of 8-10 and conditioned with a tall oil-fatty acid collector. The conditioned pulp is subjected to froth flotation to float off a portion of the iron carbonate. The underflow is treated with a cationic amine collector and subjected to a second froth flotation to float off the silica sand, leaving the iron carbonate in the cell underflow. The froth concentrate of silica may be leached with sulfuric acid to reduce its content of iron oxide to a very low percentage.[21]

[19] Engineering News-Record. Recycled Trash as Roadbase Is Gold as State Saves $1 Million. V. 194, No. 11, Mar. 13, 1975, pp. 17–18.

[20] Sand and Gravel Association Ltd. Bulletin. More of This Than Meets the Eye. V. 7, No. 4, October–December 1975, p. 8.

[21] Slade, W. W. (asigned to Owens-Illinois Inc.). Froth Flotation. U.S. Pat. 3,914,385, Oct. 21, 1975.

Table 2.—Construction aggregate (blended sand and gravel) and industrial sand and gravel produced for sale or use by commercial producers in the United States [1]

(Thousand short tons and thousand dollars)

	1974		1975	
	Quantity	Value [2]	Quantity	Value
Construction aggregate:				
Processed sand and gravel	703,150	r 1,152,574	576,460	1,128,156
Unprocessed sand and gravel	r 138,502	r 97,084	96,427	90,297
Industrial:				
Sand	28,024	135,357	26,723	146,982
Gravel	1,046	3,342	560	2,996
Total	r 870,722	r 1,388,357	700,170	1,368,431

r Revised.

[1] Data not directly comparable with those years prior to 1973 because of changes in canvass form.

[2] Unit value of construction aggregate may be higher than unit value of sand or gravel.

Table 3.—Construction aggregate (blended sand and gravel) and industrial sand and gravel produced by Federal, State, or county crews from their own operations for sale or use [1] [2]

(Thousand short tons and thousand dollars)

	1974		1975	
	Quantity	Value	Quantity	Value
Construction aggregate:				
Processed sand and gravel	23,868	25,763	42,592	33,445
Unprocessed sand and gravel	10,056	7,117	46,670	14,470
Industrial:				
Sand	--	--	--	--
Gravel	--	--	--	--
Total	33,924	32,880	89,262	47,915

[1] Data not directly comparable with those of previous years because of changes in canvass form.
[2] Unit value of construction aggregate may be higher than unit value of sand and gravel.

Table 4.—Construction aggregate (blended sand and gravel) sold or used by producers in the United States for commercial or publicly funded construction projects, or products [1]

(Thousand short tons and thousand dollars)

	1974				1975			
	Commercial		Publicly funded projects		Commercial		Publicly funded projects	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Processed:								
Concrete aggregate (including use in ready-mixed concrete):								
Nonresidential and residential construction	214,840	376,890	10,001	16,974	179,696	377,722	9,833	21,205
Highway and bridge construction	29,389	50,472	44,128	72,169	25,344	49,873	41,182	81,495
Other construction (dams, waterworks, airports, etc.)	13,242	23,646	6,373	10,834	10,773	21,273	5,125	10,550
Concrete products (cement blocks, bricks, pipe, etc.)	68,259	125,002	3,504	6,465	58,599	119,970	2,696	5,741
Bituminous paving (asphalt and tar paving)	81,053	129,487	r 57,708	r 93,296	62,143	117,546	53,351	105,341
Roadbase and subbase	r 76,122	r 112,912	r 70,220	r 95,975	59,341	91,809	62,367	91,115
Fill	r 32,007	r 36,975	5,283	6,133	30,183	33,717	5,655	7,027
Other	11,647	19,408	3,240	4,695	8,832	18,246	3,933	6,912
Unprocessed:								
Fill	r 74,272	r 53,376	10,065	7,223	55,367	40,358	18,576	10,020
Roadbase and subbase	r 49,170	r 32,070	15,050	8,536	33,765	26,726	32,001	22,892
Other	--	--	--	--	5,477	4,498	2,912	2,333
Total	r [2] 650,002	r 960,238	r 225,572	r 322,300	529,520	901,738	232,631	364,631

r Revised.
[1] Data not directly comparable with those of years previous to 1974 because of changes in canvass form.
[2] Data do not add to totals shown because of independent rounding.

Table 5.—Construction aggregate (blended sand and gravel) and industrial sand and gravel production by State

(Thousand short tons and thousand dollars)

State	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Alabama	12,454	19,120	9,232	17,376
Alaska	r 43,644	r 22,954	48,145	25,780
Arizona	23,417	41,906	17,222	36,490
Arkansas	14,878	29,922	12,415	25,794
California	105,191	176,213	88,445	168,248
Colorado	23,793	39,674	20,019	34,850
Connecticut	6,345	11,272	4,900	10,040
Delaware	2,396	3,783	976	1,900
Florida	24,372	33,400	13,237	20,199
Georgia	4,989	9,639	5,105	8,818
Hawaii	990	2,379	671	2,460
Idaho	7,665	10,484	6,881	12,768
Illinois	42,705	68,566	39,000	83,515
Indiana	26,077	35,656	21,641	35,234
Iowa	17,091	26,104	15,410	26,844
Kansas	11,687	13,388	10,866	13,467
Kentucky	8,710	12,887	8,924	14,466
Louisiana	12,341	27,781	14,587	35,990
Maine	8,755	10,673	9,875	11,403
Maryland	11,690	29,386	11,786	29,477
Massachusetts	17,334	26,565	13,281	24,556
Michigan	60,027	82,617	47,051	73,397
Minnesota	36,720	42,370	33,398	45,214
Mississippi	14,439	19,487	14,372	23,098
Missouri	10,933	19,462	9,752	18,216
Montana	4,242	6,126	4,127	6,963
Nebraska	13,231	17,727	11,759	16,901
Nevada	8,736	14,515	8,056	16,848
New Hampshire	6,126	8,223	5,150	9,077
New Jersey	17,924	47,292	13,012	39,640
New Mexico	7,413	10,605	6,220	13,798
New York	30,614	46,652	22,158	44,064
North Carolina	12,784	20,844	8,169	15,610
North Dakota	4,991	6,211	5,636	8,133
Ohio	41,353	68,258	37,195	68,552
Oklahoma	8,707	13,772	9,591	16,749
Oregon	18,558	30,948	16,527	29,596
Pennsylvania	18,071	45,181	17,401	48,742
Rhode Island	2,784	4,605	2,910	5,070
South Carolina	7,380	13,054	7,363	14,128
South Dakota	9,028	9,720	6,481	8,668
Tennessee	10,702	19,476	10,909	22,102
Texas	42,466	81,364	38,649	87,106
Utah	11,578	12,985	10,159	14,342
Vermont	2,394	3,588	2,356	3,693
Virginia	14,314	29,270	9,895	24,776
Washington	22,842	35,030	19,069	32,990
West Virginia	5,382	16,018	5,068	17,872
Wisconsin	28,850	34,577	30,057	40,580
Wyoming	5,532	9,508	4,328	10,746
Total	r 904,646	r 1,421,237	789,436	1,416,346

r Revised.

Table 6.—Construction sand and gravel used in the United States in 1975, by State and use[1]

(Thousand short tons and thousand dollars)

	Concrete aggregate (including use in ready-mixed concrete)											
	Nonresidential and residential construction				Highway and bridge construction				Other construction (dams, waterworks, airports, etc.)			
	Commercial		Publicly funded projects		Commercial		Publicly funded projects		Commercial		Publicly funded projects	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	2,323	4,369	31	57	608	1,446	1,420	2,988	145	269	183	351
Alaska	181	779	W	W	85	336	18	82	W	W	43	214
Arizona	4,147	9,933	318	573	327	749	210	537	343	1,016	W	W
Arkansas	2,792	6,102	99	168	450	1,107	415	732	192	458	39	55
California	23,995	49,697	1,510	3,175	2,897	5,337	1,742	3,344	2,672	4,319	1,098	2,356
Colorado	3,866	8,966	395	1,037	198	473	500	1,141	202	450	156	316
Connecticut	1,249	3,123	83	238	150	315	67	176	61	154	W	W
Delaware	155	504	--	--	24	91	W	W	24	91	W	W
Florida	3,784	5,592	140	176	220	362	823	1,152	80	97	173	195
Georgia	2,118	3,500	45	62	255	423	116	197	45	55	W	W
Hawaii	171	690	--	--	28	139	--	--	8	13	--	--
Idaho	1,177	3,195	8	20	131	359	237	442	108	271	155	341
Illinois	9,455	16,345	116	197	2,241	3,596	2,848	5,610	251	435	175	382
Indiana	5,787	10,449	83	144	1,187	2,149	1,485	2,436	257	456	70	114
Iowa	3,823	8,114	157	306	402	687	1,886	3,989	162	270	61	112
Kansas	2,763	4,140	191	341	247	327	1,072	1,362	100	144	118	157
Kentucky	3,569	6,143	W	W	102	201	190	379	W	W	20	31
Louisiana	5,597	13,906	190	527	1,111	1,997	1,255	3,294	347	635	--	--
Maine	682	1,539	5	13	22	88	79	198	82	174	41	57
Maryland	4,161	11,908	169	538	181	565	1,165	2,884	133	396	W	W
Massachusetts	3,812	8,678	501	1,149	334	804	170	444	172	496	121	288
Michigan	8,011	14,981	197	230	1,402	2,097	2,078	3,179	451	722	67	124
Minnesota	4,498	9,696	262	513	1,264	2,300	1,119	1,878	79	198	15	44
Mississippi	2,930	5,258	83	159	612	1,241	1,622	3,663	W	W	159	336
Missouri	3,336	5,160	32	87	359	594	646	1,125	181	245	17	27
Montana	690	1,930	47	96	77	252	52	124	52	184	W	W
Nebraska	1,718	2,369	50	92	575	876	2,188	3,505	335	398	129	123
Nevada	1,940	4,111	160	349	53	105	119	314	72	144	W	W
New Hampshire	1,438	3,141	68	126	69	145	126	259	48	111	16	32
New Jersey	2,329	6,070	76	166	710	1,686	W	W	219	373	44	127
New Mexico	2,073	5,010	80	223	112	320	208	549	163	452	76	309
New York	5,857	15,537	329	834	782	1,645	1,860	4,585	241	652	142	269
North Carolina	1,979	4,811	31	50	88	133	343	778	3	6	9	W
North Dakota	1,100	2,549	165	278	W	W	118	169	113	235	W	W
Ohio	9,024	17,233	1,032	1,993	639	1,136	2,637	5,081	200	382	294	533
Oklahoma	3,057	5,143	151	197	377	568	291	419	77	103	161	219
Oregon	2,272	4,597	235	477	220	383	943	1,497	128	249	472	944
Pennsylvania	4,775	12,943	286	823	1,125	2,661	1,703	4,074	510	1,512	88	230
Rhode Island	356	700	222	492	176	324	293	642	W	W	1	2
South Carolina	867	1,633	9	16	W	W	697	1,518	W	W	W	W
South Dakota	729	1,237	119	198	197	342	460	805	25	55	W	W

See footnotes at end of table.

Table 6.—Construction sand and gravel used in the United States in 1975, by State and use [1]—Continued

(Thousand short tons and thousand dollars)

	Concrete aggregate (including use in ready-mixed concrete)											
	Nonresidential and residential construction				Highway and bridge construction				Other construction (dams, waterworks, airports, etc.)			
	Commercial		Publicly funded projects		Commercial		Publicly funded projects		Commercial		Publicly funded projects	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Tennessee	1,854	4,068	W	W	554	1,254	519	1,006	W	W	20	68
Texas	16,523	37,539	576	1,161	1,884	4,058	2,632	6,008	886	1,881	475	1,139
Utah	1,477	2,222	71	109	237	464	143	284	130	215	11	16
Vermont	410	876	55	90	67	134	96	155	W	W	12	26
Virginia	2,857	7,577	657	1,945	441	907	626	1,681	42	106	W	W
Washington	4,602	8,609	142	341	878	1,526	1,024	2,134	544	807	148	366
West Virginia	1,346	3,863	W	W	342	1,509	W	W	42	146	W	W
Wisconsin	5,104	8,148	152	221	510	944	1,622	2,009	81	124	170	252
Wyoming	928	3,038	199	472	349	645	102	419	66	182	9	37
Concealments	--	--	308	746	42	70	1,218	2,250	700	1,595	138	357
Total [3]	179,696	377,722	9,833	21,205	25,344	49,873	41,182	81,495	10,773	21,273	5,125	10,550

	Concrete aggregate (including use in ready-mixed concrete)				Bituminous paving (asphalt and tar paving)				Roadbase and subbase			
	Concrete products (cement blocks, bricks, pipe, etc.)											
	Commercial		Publicly funded projects		Commercial		Publicly funded projects		Commercial		Publicly funded projects	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	1,176	2,314	W	W	206	496	602	1,232	362	566	100	156
Alaska	177	949	--	--	89	671	151	1,678	8,113	4,550	573	2,087
Arizona	1,441	3,896	W	W	1,602	2,893	1,579	3,876	3,472	6,636	1,134	2,267
Arkansas	1,482	2,869	--	--	1,119	2,431	647	1,585	488	871	443	844
California	6,426	11,123	144	238	11,361	22,576	7,457	15,942	8,158	13,712	6,735	11,511
Colorado	1,163	2,764	53	114	1,365	2,132	1,734	2,438	2,221	3,551	3,656	5,276
Connecticut	550	1,288	37	65	517	1,195	285	655	272	527	45	98
Delaware	45	154	W	W	W	W	W	35	W	W	--	--
Florida	2,382	3,512	--	--	635	861	W	W	282	453	W	W
Georgia	614	956	W	W	372	798	W	W	W	W	--	--
Hawaii	W	W	--	--	W	W	--	--	W	W	--	--
Idaho	269	752	W	W	379	758	192	399	622	1,176	1,338	1,600
Illinois	2,067	3,772	109	172	4,952	8,639	1,746	3,118	2,498	4,807	2,429	4,578
Indiana	1,581	2,686	136	204	2,716	4,875	1,385	2,306	1,386	2,291	1,097	1,797
Iowa	791	1,608	69	171	1,465	3,057	1,492	1,951	549	1,000	2,840	2,765
Kansas	499	562	43	47	496	603	917	1,157	204	293	678	801
Kentucky	1,402	2,106	--	--	1,981	3,061	187	362	703	1,067	29	63
Louisiana	1,179	3,451	113	207	911	1,896	1,349	3,974	147	218	674	1,645

Maine	102	261	9	32	375	885	1,492	2,481	517	693	993	820
Maryland	1,839	4,634	W	W	324	898	864	2,717	361	433	275	692
Massachusetts	957	2,365	137	230	1,163	2,120	324	673	561	1,050	217	379
Michigan	2,697	4,709	--	--	2,534	4,039	3,716	5,453	6,800	11,690	7,145	7,740
Minnesota	2,364	4,068	27	70	2,694	3,284	3,226	4,151	2,511	2,985	8,050	8,982
Mississippi	455	814	W	4	1,122	2,210	1,265	2,427	890	1,960	1,217	2,035
Missouri	490	844	--	--	845	1,575	285	495	1,352	1,653	96	142
Montana	133	418	--	--	88	172	412	671	370	715	590	901
Nebraska	1,289	1,788	17	22	333	552	1,328	1,880	808	1,416	1,579	2,305
Nevada	155	279	--	--	535	795	947	2,290	661	871	1,662	2,864
New Hampshire	210	444	2	3	755	1,588	225	382	168	312	114	157
New Jersey	3,228	8,153	59	153	968	2,546	443	929	179	440	82	211
New Mexico	445	1,532	22	63	167	385	894	2,073	287	461	736	1,302
New York	1,689	3,759	235	505	1,453	3,644	1,009	2,357	602	1,307	996	1,585
North Carolina	1,338	2,296	30	76	328	491	482	722	951	1,756	292	395
North Dakota	96	217	W	W	207	493	564	962	109	150	841	752
Ohio	2,515	4,703	53	87	8,993	16,273	2,468	4,984	1,832	3,427	782	1,408
Oklahoma	574	946	--	--	166	335	120	274	213	334	113	121
Oregon	1,001	2,069	W	W	1,077	2,189	2,857	4,949	2,027	4,234	2,055	3,886
Pennsylvania	1,937	5,215	218	451	1,052	2,756	1,801	5,790	760	1,828	557	1,100
Rhode Island	208	404	--	--	240	542	150	323	71	115	W	W
South Carolina	1,272	2,246	--	--	119	133	767	1,815	W	W	18	33
South Dakota	124	258	W	W	177	300	546	1,196	809	746	1,506	1,839
Tennessee	1,597	3,651	28	W	767	1,528	669	1,455	493	703	952	1,198
Texas	3,332	7,644	W	W	775	2,028	1,482	3,389	1,111	2,372	504	1,064
Utah	441	866	31	56	630	1,005	1,088	2,446	1,218	1,696	1,241	1,777
Vermont	156	351	--	--	210	558	171	376	164	322	95	149
Virginia	1,549	4,169	W	W	270	513	133	300	192	472	W	W
Washington	905	2,346	212	388	1,199	2,248	676	1,290	1,136	2,372	1,319	2,656
West Virginia	W	W	--	--	W	W	W	W	--	--	16	95
Wisconsin	1,711	2,296	97	140	1,772	2,509	2,350	3,449	2,105	2,487	5,404	6,661
Wyoming	13	55	W	W	463	1,460	484	1,312	399	788	559	994
Concealments	531	1,415	814	2,243	176	551	388	620	211	305	591	1,380
Total [3]	58,599	119,970	2,696	5,741	62,143	117,546	53,351	105,341	59,841	91,809	62,367	91,115

See footnotes at end of table.

Table 6.—Construction sand and gravel used in the United States in 1975, by State and use[1]—Continued

(Thousand short tons and thousand dollars)

State	Fill: Commercial: Quantity	Fill: Commercial: Value	Fill: Publicly funded projects: Quantity	Fill: Publicly funded projects: Value	Other: Commercial: Quantity	Other: Commercial: Value	Other: Publicly funded projects: Quantity	Other: Publicly funded projects: Value	Unprocessed sand and gravel: Fill: Commercial: Quantity	Unprocessed sand and gravel: Fill: Commercial: Value	Unprocessed sand and gravel: Fill: Publicly funded projects: Quantity	Unprocessed sand and gravel: Fill: Publicly funded projects: Value
Alabama	88	168	--	--	31	50	--	--	279	259	23	8
Alaska	8,014	3,039	325	48	287	403	436	796	14,343	4,060	1,549	1,176
Arizona	624	1,429	86	117	196	436	W	188	625	764	96	46
Arkansas	314	458	10	27	53	174	W	W	297	239	169	93
California	3,634	4,538	681	758	1,825	4,123	82	198	3,192	2,844	302	201
Colorado	318	419	152	133	362	853	129	248	417	414	141	56
Connecticut	219	304	9	14	99	205	139	293	474	660	223	232
Delaware	W	W	W	12	--	--	--	--	64	142	W	W
Florida	442	519	W	W	W	W	--	--	2,394	1,694	W	W
Georgia	14	23	7	W	3	17	--	--	644	431	20	10
Hawaii	--	--	--	--	W	W	--	--	100	133	--	--
Idaho	185	280	67	120	35	73	18	44	315	328	600	550
Illinois	1,869	2,911	471	753	248	451	--	--	1,420	1,681	515	682
Indiana	1,219	1,503	280	316	214	386	170	224	1,305	1,323	169	91
Iowa	525	695	141	188	54	122	120	160	526	579	43	40
Kansas	988	1,079	155	163	92	185	87	135	356	271	19	10
Kentucky	233	322	10	15	W	W	--	--	229	206	12	8
Louisiana	33	28	23	18	132	357	8	8	110	153	17	19
Maine	383	481	155	230	223	300	590	725	897	502	1,179	788
Maryland	461	656	W	W	W	W	--	--	283	324	333	486
Massachusetts	630	868	37	93	222	466	174	390	1,452	1,294	811	678
Michigan	720	893	872	799	398	921	80	101	2,640	1,578	756	221
Minnesota	889	1,230	179	225	334	555	211	247	2,371	1,374	676	250
Mississippi	37	43	W	W	--	--	--	--	180	125	328	287
Missouri	554	864	W	W	161	340	W	W	117	122	4	2
Montana	82	100	20	31	W	W	7	9	244	235	123	96
Nebraska	383	445	20	21	65	69	39	71	141	125	37	22
Nevada	189	285	W	29	W	W	W	W	461	247	20	23
New Hampshire	69	109	W	W	454	1,160	83	121	458	315	68	24
New Jersey	201	350	36	73	103	263	37	96	1,153	1,137	81	64
New Mexico	185	284	33	50	130	268	60	105	126	121	31	19
New York	507	682	140	184	128	267	369	657	2,031	1,906	1,141	809
North Carolina	33	41	--	--	27	54	--	--	564	430	119	110
North Dakota	W	W	W	W	--	--	110	83	196	254	266	189
Ohio	1,506	2,406	163	277	439	807	72	139	2,472	2,337	207	194
Oklahoma	238	154	18	10	164	754	--	--	1,231	749	60	51
Oregon	721	1,385	87	163	198	350	25	36	943	1,137	483	181
Pennsylvania	150	318	232	549	140	348	108	209	359	379	104	95
Rhode Island	112	141	--	--	W	W	W	W	218	211	W	W
South Carolina	63	55	--	--	W	W	19	48	216	122	W	W
South Dakota	52	55	547	465	32	77	W	W	261	225	184	122
Tennessee	103	162	129	295	117	270	W	W	266	262	213	198
Texas	511	722	39	61	87	188	--	--	3,505	2,806	163	147

Utah	137	179	W	W	955	1,280	4	18	597	405	767	507
Vermont	20	20	W	W	45	93	122	78	165	126	64	--
Virginia	623	538	--	--	83	196	W	W	698	734	16	7
Washington	464	773	154	272	120	327	9	13	2,347	3,208	761	779
West Virginia	--	--	--	--	--	--	--	--	--	--	--	--
Wisconsin	1,279	1,380	118	123	38	55	72	91	1,623	1,300	465	253
Wyoming	148	360	64	W	W	W	--	--	60	86	(2)	(2)
Concealments	15	24	195	395	534	1,001	552	1,379	--	--	218	181
Total [3]	30,183	33,717	5,655	7,027	8,832	18,246	3,933	6,912	55,365	40,357	13,576	10,022

	Unprocessed sand and gravel							
	Roadbase and subbase				Other			
	Commercial		Publicly funded projects		Commercial		Publicly funded projects	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	156	123	664	234	--	--	--	--
Alaska	12,386	3,403	541	583	W	W	648	652
Arizona	504	342	458	513	9	17	1	(2)
Arkansas	519	455	2,242	1,365	64	25	68	W
California	1,926	2,856	837	495	328	237	186	77
Colorado	734	609	1,499	950	493	745	129	186
Connecticut	208	247	183	204	W	W	--	--
Delaware	W	W	W	W	--	--	W	1
Florida	214	251	W	W	222	152	W	W
Georgia	140	76	213	95	71	130	--	--
Hawaii	252	1,241	--	--	W	W	--	--
Idaho	347	340	554	491	--	--	7	2
Illinois	632	988	449	731	31	35	76	82
Indiana	236	238	531	281	8	6	7	3
Iowa	103	179	9	8	39	46	--	--
Kansas	128	84	1,124	551	W	W	188	120
Kentucky	123	113	29	7	--	--	--	--
Louisiana	317	569	530	744	W	W	--	--
Maine	685	498	1,148	544	36	15	177	71
Maryland	354	617	468	610	W	W	W	W
Massachusetts	837	977	450	514	123	50	14	21
Michigan	328	238	1,718	526	59	54	10	3
Minnesota	658	358	1,336	626	215	77	143	51
Mississippi	518	394	2,874	2,022	W	W	--	--
Missouri	306	348	101	78	W	W	--	--
Montana	241	289	809	590	--	--	18	14
Nebraska	132	128	497	401	W	W	38	19
Nevada	W	W	294	127	--	--	15	W
New Hampshire	246	232	389	250	135	151	5	1
New Jersey	184	254	117	126	--	--	--	--
New Mexico	91	74	300	198	--	--	--	--
New York	1,289	1,279	971	603	155	190	97	79
North Carolina	328	254	360	175	293	281	33	45
North Dakota	273	278	1,400	1,394	--	--	W	W
Ohio	607	694	320	282	159	116	2	3

See footnotes at end of table.

Table 6.—Construction sand and gravel used in the United States in 1975, by State and use [1]—Continued
(Thousand short tons and thousand dollars)

	Unprocessed sand and gravel							
	Roadbase and subbase				Other			
	Commercial		Publicly funded projects		Commercial		Publicly funded projects	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Oklahoma	186	69	514	298	557	202	244	163
Oregon	569	643	174	133	7	11	W	W
Pennsylvania	138	161	5	W	347	173	--	--
Rhode Island	156	62	348	238	--	--	--	--
South Carolina	119	82	W	W	1,325	838	379	129
South Dakota	119	134	553	558	W	W	W	W
Tennessee	554	607	975	829	--	--	--	--
Texas	2,090	2,605	454	879	13	60	118	114
Utah	655	431	257	216	--	--	33	24
Vermont	190	129	279	121	11	13	--	--
Virginia	332	298	19	17	11	9	(2)	W
Washington	1,351	1,224	964	909	W	W	12	8
West Virginia	--	--	48	82	--	--	--	--
Wisconsin	731	537	3,238	1,370	6	2	104	65
Wyoming	44	62	136	211	16	W	5	16
Concealments	526	657	623	714	745	863	156	385
Total [3]	33,762	26,727	32,002	22,893	5,478	4,498	2,913	2,334

W Withheld to avoid disclosing individual company confidential data; included with "Concealments."
[1] Data not directly comparable with those of years prior to 1974 because of changes in canvass form.
[2] Less than ½ unit.
[3] Data may not add to totals shown because of independent rounding.

Table 7.—Industrial sand and gravel sold or used by all producers in the United States
(Thousand short tons and thousand dollars)

	1974		1975	
	Quantity	Value	Quantity	Value
Unground sand:				
Molding	7,462	33,328	6,455	32,371
Glass	10,040	46,632	10,211	54,703
Blast	2,136	11,281	1,371	11,812
Grinding and polishing	99	558	87	299
Fire or furnace	399	1,752	210	1,251
Engine	524	2,073	686	2,624
Filtration	305	1,639	191	1,381
Metallurgical	364	1,286	1,548	4,572
Oil (Hydrafrac)	383	3,447	371	4,279
Other	2,107	8,824	2,601	12,983
Total	23,820	110,821	23,731	126,275
Ground sand:				
Filter	208	2,865	123	2,474
Chemical	404	1,719	115	869
Enamel	W	W	W	W
Abrasives	325	2,823	375	3,616
Foundry	2,095	8,627	1,554	6,467
Glass	850	5,004	535	3,463
Pottery, porcelain, tile	136	1,552	85	1,173
Other	186	1,944	206	2,646
Total	4,204	24,536	2,992	20,707
Gravel:				
Metallurgical	1,004	3,141	448	2,180
Other	43	201	112	816
Total	1,046	3,342	560	2,996
Grand total[1]	29,070	138,699	27,283	149,978

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Data may not add to totals shown because of independent rounding.

Table 8.—Industrial sand and gravel sold or used by all producers in the United States in 1974 and 1975, by State

(Thousand short tons and thousand dollars)

	1974		1975	
	Quantity	Value	Quantity	Value
Alabama	503	1,395	828	2,271
Arizona	179	897	W	W
Arkansas	W	W	477	5,558
California	2,185	12,231	1,252	8,592
Colorado	W	W	138	1,580
Florida	727	3,940	710	4,131
Georgia	358	2,430	343	1,875
Idaho	323	764	128	1,205
Illinois	2,084	8,738	4,400	23,551
Indiana	266	804	331	953
Iowa	195	1,012	W	W
Kansas	203	918	241	856
Kentucky	49	202	22	232
Louisiana	282	1,648	341	2,069
Maine	W	W	W	W
Massachusetts	W	W	63	528
Michigan	5,167	14,039	4,372	13,099
Minnesota	W	W	W	W
Mississippi	W	W	W	W
Missouri	1,390	5,991	824	4,456
Montana	--	--	W	W
Nebraska	50	266	47	270
Nevada	297	1,381	W	W
New Hampshire	W	W	W	W
New Jersey	3,247	17,272	2,730	16,321
New York	124	544	135	732
North Carolina	1,049	3,869	539	2,691
Ohio	857	3,954	779	4,059
Oklahoma	907	4,572	1,078	5,640
Oregon	W	W	W	W
Pennsylvania	1,099	6,508	1,005	7,120
Rhode Island	W	W	W	W
South Carolina	773	3,884	609	4,036
Tennessee	758	3,606	693	3,591
Texas	1,391	8,595	1,318	11,009
Utah	W	W	W	W
Vermont	W	W	W	W
Virginia	405	2,072	478	2,757
Washington	239	1,966	W	W
West Virginia	W	W	W	W
Wisconsin	1,376	5,813	1,304	6,165
Wyoming	1	6	--	--
Concealments	2,586	19,382	2,098	14,631
Total	29,070	138,699	27,283	149,978

W Withheld to avoid disclosing individual company confidential data; included with "Concealments."

Table 9.—Number and production of construction sand and gravel and industrial sand and gravel operations, by size[1]

Size	Construction				Industrial				Construction-Industrial			
	Operations		Production		Operations		Production		Operations		Production	
	Number	Percent of total	Thousand short tons	Percent of total	Number	Percent of total	Thousand short tons	Percent of total	Number	Percent of total	Thousand short tons	Percent of total
1974												
Less than 25,000	r 2,211	r 32.8	r 21,372	r 2.5	24	20.3	229	1.0	13	12.9	178	0.6
25,000 to 50,000	r 1,140	16.9	r 41,391	r 4.9	14	11.9	536	2.4	8	7.9	308	1.0
50,000 to 100,000	r 1,257	r 18.6	r 90,083	r 10.5	22	18.6	1,516	6.7	17	16.8	1,228	4.2
100,000 to 200,000	r 1,070	r 15.9	r 150,716	r 17.7	18	15.2	2,578	11.5	27	26.7	3,915	13.4
200,000 to 300,000	r 416	r 6.2	r 100,200	r 11.7	16	13.6	3,763	16.8	8	7.9	1,890	6.4
300,000 to 400,000	r 198	r 2.9	r 67,241	r 7.9	10	8.5	3,399	15.1	6	5.9	2,115	7.2
400,000 to 500,000	r 133	2.0	r 59,635	r 7.0	3	2.5	1,430	6.4	2	2.0	952	3.2
500,000 to 600,000	r 95	1.4	r 51,968	r 6.1	5	4.2	2,774	12.4	5	5.0	2,740	9.4
600,000 to 700,000	r 57	r .8	r 36,717	r 4.3	1	.9	600	2.7	1	1.0	653	2.2
700,000 to 800,000	r 43	.6	r 32,083	r 3.8	1	.9	741	3.3	3	3.0	2,269	7.8
800,000 to 900,000	r 20	.3	r 16,827	r 2.0	--	--	--	--	3	3.0	2,504	8.6
900,000 to 1,000,000	31	.5	28,428	r 3.3	2	1.7	1,911	8.5	1	1.0	908	3.1
1,000,000 and over	r 77	r 1.1	r 156,127	r 18.3	2	1.7	2,975	13.2	7	6.9	9,634	32.9
Total[2]	r 6,748	100.0	r 852,788	100.0	118	100.0	22,452	100.0	101	100.0	29,294	100.0
1975												
Less than 25,000	2,453	36.1	24,870	3.5	27	22.0	300	1.3	14	15.2	200	.9
25,000 to 50,000	1,164	17.1	42,411	6.0	27	22.0	990	4.3	9	9.8	340	1.6
50,000 to 100,000	1,224	18.0	86,105	12.2	19	15.4	1,391	6.1	17	18.5	1,255	5.9
100,000 to 200,000	1,030	15.4	143,152	20.3	19	15.4	3,043	13.4	21	22.7	2,988	14.0
200,000 to 300,000	383	5.5	92,356	13.1	9	7.3	2,290	10.1	9	9.8	2,209	10.4
300,000 to 400,000	182	2.7	62,917	8.9	2	1.6	726	3.2	9	9.8	3,071	14.4
400,000 to 500,000	124	1.7	54,612	7.8	8	6.6	3,492	15.3	1	1.1	420	2.0
500,000 to 600,000	74	1.1	39,175	5.6	5	4.1	2,801	12.3	3	3.3	1,578	7.4
600,000 to 700,000	33	.5	21,269	3.0	1	.8	634	2.8	2	2.2	1,291	6.1
700,000 to 800,000	38	.6	28,209	4.0	--	--	--	--	1	1.1	740	3.5
800,000 to 900,000	29	.4	24,605	3.5	2	1.6	1,687	7.4	1	1.1	870	4.1
900,000 to 1,000,000	15	.2	14,316	2.0	1	.8	910	4.0	1	1.1	925	4.3
1,000,000 and over	50	.7	70,885	10.1	3	2.4	4,510	19.8	4	4.3	5,421	25.4
Total[2]	6,799	100.0	704,880	100.0	123	100.0	22,774	100.0	92	100.0	21,310	100.0

r Revised.
[1] Excludes operations and tonnage produced for use in the construction of the oil pipeline in Alaska, (1974, 1975).
[2] Data may not add to totals shown because of independent rounding.

Table 10.—Sand and gravel sold or used in the United States, by method of transportation to customer or site of use

	1974		1975	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Truck	r 782,888	r 86	682,874	86
Rail	54,158	r 6	38,944	5
Waterway	24,421	r 3	30,315	4
Not shipped, used at site	36,382	4	31,107	4
Unspecified	6,797	1	6,196	1
Total	r 904,646	100	789,436	100

r Revised.

Table 11.—Number of processing plants associated with sand and gravel operations in 1975 in the United States[1]

State	Number of operations	Plant associated with wet or dry pit: Plant at pit site: Stationary	Plant at pit site: Portable	Plant not at pit site (stationary or portable)	No plant	Plant associated with dredge: Plant on board	Plant on land	No plant
Alabama	73	38	6	1	13	4	10	1
Alaska	[2] 54	6	15	1	28	1	1	2
Arizona	173	64	81	10	17	--	1	--
Arkansas	226	35	46	7	110	9	13	4
California	389	221	81	14	61	2	4	6
Colorado	210	42	118	7	31	7	3	--
Connecticut	62	33	22	2	5	--	--	--
Delaware	10	5	--	--	2	--	2	1
Florida	70	24	7	--	9	2	26	4
Georgia	62	19	2	1	29	2	6	--
Hawaii	11	3	4	--	4	--	--	--
Idaho	99	30	47	5	12	--	2	3
Illinois	204	85	79	4	23	5	12	5
Indiana	186	71	51	3	30	1	27	3
Iowa	234	72	129	2	19	1	7	4
Kansas	149	34	26	2	38	5	37	5
Kentucky	39	9	2	3	8	10	7	--
Louisiana	84	20	7	1	6	8	39	3
Maine	97	30	42	2	22	--	--	1
Maryland	58	32	6	14	3	--	3	--
Massachusetts	138	82	19	7	27	--	1	2
Michigan	478	123	274	8	54	3	12	4
Minnesota	440	87	281	18	53	--	--	1
Mississippi	61	16	6	2	14	--	22	1
Missouri	92	24	24	4	3	11	22	4
Montana	68	28	25	4	11	--	1	--
Nebraska	225	24	52	4	19	30	89	7
Nevada	82	28	37	6	9	--	1	1
New Hampshire	45	33	8	2	2	--	--	--
New Jersey	73	36	10	3	9	--	13	2
New Mexico	127	31	77	6	10	--	1	2
New York	303	123	85	7	77	1	5	5
North Carolina	148	29	24	4	67	3	18	3
North Dakota	80	15	41	1	21	--	--	2
Ohio	327	195	39	11	58	3	15	8
Oklahoma	130	22	18	3	40	5	33	8
Oregon	152	57	50	9	26	1	9	--
Pennsylvania	112	74	14	5	9	4	6	--
Rhode Island	19	12	3	1	2	--	--	1
South Carolina	65	15	4	1	27	2	13	3
South Dakota	155	21	95	2	34	1	1	--
Tennessee	96	39	12	3	25	7	9	1
Texas	183	99	22	13	35	1	10	3
Utah	90	36	39	2	13	--	--	--
Vermont	48	13	22	2	9	--	1	1
Virginia	107	32	9	3	51	1	5	5
Washington	187	55	64	8	55	--	3	1
West Virginia	14	2	2	--	--	6	1	3
Wisconsin	407	86	228	30	55	1	1	6
Wyoming	72	9	53	5	4	--	--	--
Total	7,014	2,319	2,408	253	1,289	137	492	116

[1] Some operations have more than 1 plant on location for processing mined material from a single pit.
[2] Excludes operations supplying sand and gravel for the construction of the oil pipeline in Alaska.

Table 12.—Number of operations by source of water used for sand and gravel processing, by State [1]

State	River	Lake	Bay	Pit created by operation	Purchased from municipal source	Well or other source	No water used in processing
Alabama	15	4	--	24	--	4	5
Alaska	[2] 2	1	--	3	--	1	9
Arizona	2	1	--	9	34	58	49
Arkansas	28	6	--	27	4	13	28
California	41	3	--	40	29	122	71
Colorado	17	--	--	46	2	9	86
Connecticut	7	2	--	5	--	2	14
Delaware	2	1	--	3	--	1	--
Florida	1	5	--	36	--	9	2
Georgia	7	1	--	13	--	6	--
Hawaii	--	--	--	--	--	--	1
Idaho	12	--	--	7	3	5	43
Illinois	9	5	--	44	--	5	15
Indiana	7	6	--	71	--	16	45
Iowa	19	--	3	46	--	1	12
Kansas	22	1	--	38	--	7	16
Kentucky	16	--	--	2	1	4	8
Louisiana	7	5	--	44	--	7	1
Maine	7	1	--	7	2	5	48
Maryland	8	4	1	7	--	20	14
Massachusetts	9	7	--	23	3	20	15
Michigan	12	14	2	122	1	38	208
Minnesota	6	12	--	44	1	48	252
Mississippi	2	4	--	24	--	12	5
Missouri	39	2	--	7	1	2	22
Montana	8	1	--	9	--	4	23
Nebraska	7	9	--	114	2	12	33
Nevada	2	--	--	3	--	15	8
New Hampshire	10	1	1	3	--	7	5
New Jersey	8	2	--	23	--	9	5
New Mexico	8	--	--	1	4	16	77
New York	17	6	--	55	2	43	69
North Carolina	15	4	--	21	--	2	35
North Dakota	8	1	--	6	--	6	8
Ohio	27	16	--	88	1	63	55
Oklahoma	28	2	--	23	--	9	14
Oregon	24	1	--	15	--	23	29
Pennsylvania	25	4	--	27	--	25	20
Rhode Island	2	3	--	3	--	2	4
South Carolina	7	3	--	14	--	2	8
South Dakota	5	--	--	17	--	3	27
Tennessee	15	7	1	9	--	17	18
Texas	18	8	--	55	2	29	16
Utah	3	--	--	1	9	7	11
Vermont	8	2	--	--	1	6	20
Virginia	15	3	--	6	--	2	9
Washington	11	1	1	11	4	20	43
West Virginia	7	--	--	--	--	--	3
Wisconsin	7	2	--	61	2	55	189
Wyoming	6	--	--	8	--	10	40
Total	588	161	9	1,265	108	802	1,738

[1] Based on 4,564 operations which completed the 1975 supplemental form.
[2] Excludes operations supplying sand and gravel for the construction of the oil pipeline in Alaska.

Table 13.—Water needed and waste generated in processing sand and gravel [1]

State	Water needed to process ton of sand and gravel [2] (gallons)	Output of responding companies, as percent of total State processed production	Waste generated in producing 1 ton of processed sand and gravel [3] (pounds)	Output of responding companies as percent of total State processed production
Alabama	29	61	2	42
Arizona	206	38	159	42
Arkansas	379	54	354	57
California	371	60	218	61
Colorado	248	40	197	56
Connecticut	251	46	171	47
Delaware	23	59	133	91
Florida	589	50	346	72
Georgia	417	57	166	52
Idaho	390	30	418	35
Indiana	531	42	123	32
Illinois	488	72	385	63
Iowa	497	21	159	20
Kansas	18	57	20	52
Kentucky	434	38	58	36
Louisiana	588	49	343	61
Maine	161	15	103	24
Maryland	317	44	138	47
Massachusetts	313	62	141	56
Michigan	569	51	563	54
Minnesota	150	36	188	35
Mississippi	467	51	1,107	55
Missouri	642	56	595	56
Montana	134	29	78	34
Nebraska	2,042	53	2,195	60
Nevada	411	52	250	30
New Hampshire	215	71	200	70
New Jersey	438	44	176	39
New Mexico	365	49	311	56
New York	480	66	96	73
North Carolina	1,167	64	338	70
North Dakota	390	54	71	66
Ohio	253	75	221	70
Oklahoma	1,296	54	393	49
Oregon	235	73	178	57
Pennsylvania	797	61	186	61
Rhode Island	175	66	344	70
South Carolina	1,390	71	1,068	79
South Dakota	213	22	95	23
Tennessee	1,278	47	576	52
Texas	466	93	427	93
Utah	267	17	68	16
Vermont	315	59	91	42
Virginia	488	82	192	80
Washington	228	57	192	72
West Virginia	339	76	722	81
Wisconsin	363	37	292	34
Wyoming	172	37	327	74
United States average	462	55	333	55

[1] Waste is defined as all undersized material, silt or clay.
[2] Based on 2,534 operations which completed the 1975 supplemental form.
[3] Based on 2,793 operations which completed the 1975 supplemental form.

Silicon

By Thomas S. Jones [1]

In contrast with 1974, the year 1975 was a difficult one for ferrosilicon and silicon metal producers. A decline in demand for silicon materials and consequent increasing availability became evident early in the year, leading to substantial worldwide reductions in production by the latter half of the year. Nevertheless, significant capacity expansions that either took place or were announced, both domestic and foreign, could lead to overcapacity by 1980, even with the return to normal levels of demand. Domestic price declines in response to weak demand were not great, because pressures from rising costs of electrical power and steel scrap were expected to continue.

Environmental concerns continued to be an important factor in plans for operating existing facilities or for designing new ones. In some foreign countries, these concerns apparently spurred producers to look outside their own country for expansion possibilities. Efforts continued at finding ways to dispose of silica dust from smelter emissions.

DOMESTIC PRODUCTION

Depressed economic conditions least affected production and shipments of 50% ferrosilicon, which, as indicated by data for the 25% to 55% ferrosilicon range, were almost as great as in 1974. Declines of one-quarter to one-half occurred for other ferrosilicon compositions and miscellaneous and specialty silicon materials. Production decreased 16% overall for silicon materials, exclusive of silicon metal, and shipments were off 22%. For silicon metal, production decreased 27% and shipments were 28% less. In Table 1, data for the 56% to 70%, 71% to 80%, and 80% to 95% ferrosilicon ranges are grouped, because only a small amount of ferrosilicon with 56% to 70% silicon was produced and ferrosilicon with 80% or more silicon content was not produced domestically. Data for silvery pig iron are withheld because there was only one producer.

Producer inventories increased for all silicon materials. In comparison with stock levels of recent years, ferrosilicon stocks increased from low to moderate levels, while those of silicon metal and specialty silicon materials went from moderate to high levels. Yearend stocks of silicon metal approximated a 2-month supply at 1974–75 rates of consumption.

Domestic production capacity for both ferrosilicon and silicon metal increased markedly. Between new facilities available for production in 1975 and those coming into production in 1976 or being engineered, scheduled capacity increases were over 200,000 annual tons for ferrosilicon (50% basis) and about 100,000 annual tons for silicon. Installation of environmental control equipment was an important part of this investment program. All primary silicon smelting continued to be by submerged arc furnace.

In ferrosilicon, the Metals Div. of Union Carbide Corp. had available throughout 1975 at Ashtabula, Ohio, a 60-megawatt (MW) computer-controlled furnace rated at 75,000 annual tons of 50% ferrosilicon. In December, Foote Mineral Co. completed the second phase of a modernization program begun in 1973 at its Graham, W. Va. plant by starting up a 24-MW furnace

[1] Physical scientist, Division of Ferrous Metals.

for production of ferrosilicon and proprietary silicon alloys. The new furnace replaced two remaining small furnaces at that plant. Planning continued on a similar furnace for the Keokuk, Iowa plant, but new construction other than for environmental control was not expected before 1977. Also at yearend, Ohio Ferro-Alloys Corp. energized a 46-megavolt-ampere (MVA) furnace at its Philo, Ohio plant, with full production expected shortly thereafter.

A 24-MW furnace being installed at the Niagara Falls, N.Y. plant of the Airco Alloys Div. of Airco, Inc. will impact future ferrosilicon production. This furnace, expected to be operational by late 1976, will increase Airco's domestic ferrosilicon capacity by 30% to 43,000 annual tons, 50% basis. Power from a combination of nuclear and hydroelectric sources will be at the lowest cost of any Airco alloys facility. Additional future production is expected by mid-1977 from a new ferrosilicon facility at Bridgeport, Ala., a joint venture of International Minerals & Chemical Corp. (IMC) and Allegheny Ludlum Industries, Inc. The new facility will be adjacent to an existing plant of Tennessee Alloys Corp. (TAC), a division of IMC. TAC will operate the new facility, which will eventually replace present smelting furnaces at the Bridgeport plant, and result in a net 50% increase in output. The new furnace is to be a 40-MW unit furnished by the American Demag Corp., with a capability of 72,000 annual tons, 50% basis. Corresponding to its equity share in the joint venture, Allegheny-Ludlum will take 25% of production on a long-term basis for use in alloy steel production.

In silicon metal, Union Carbide's Metals Div. obtained its first full year of production at Alloy, W. Va. from a 30-MW furnace rated at 18,000 annual tons. During the year, the National Metallurgical Corp. division of Kawecki Berylco Industries, Inc. completed installation of a 25-MVA Demag furnace at its Springfield, Oreg. plant and began production of silicon metal. Capacity of that plant for high-purity silicon was raised by about 9,000 tons to about 14,000 tons per year.

Several new installations for silicon metal became operational near the end of 1975, all in Alabama. In December, a second 25-MVA Demag furnace was activated at the Selma (Alamet) plant of the Globe Metallurgical Div. of Interlake, Inc. This increased productive capacity by 12,000 annual tons and, coupled with other furnaces at the Beverly, Ohio plant, raised Interlake's annual silicon metal capacity to 46,000 tons. Likewise at yearend, the first of three furnaces, a 20-MW unit, was energized at the new silicon metal plant of Ohio Ferro-Alloys Corp. at Montgomery. The other two furnaces at this plant were scheduled to go into operation in the first half of 1976. At full operation, capacity of the Montgomery plant will be 36,000 annual tons of metal, making that of the company about 75,000 annual tons. At Sheffield, Reynolds Metals Co. activated a new 16.5-MW furnace in the fourth quarter. Completion of this second furnace raised annual capacity of that plant to about 18,000 tons. Silicon metal produced will mostly be consumed captively in production of aluminum casting alloys.

The aluminum industry is also expected to be the main consumer of silicon metal scheduled to be produced beginning in 1976 at the Addy, Wash. plant of Northwest Alloys, a subsidiary of the Aluminum Co. of America. Capacity for metal was rated at 16,000 annual tons. At this facility French-developed technology is to be used to manufacture as much as 24,000 tons of magnesium per year using ferrosilicon also produced within the plant.

Table 1.—Production, shipments, and stocks of silvery pig iron, ferrosilicon, and silicon metal in 1975

(Short tons, gross weight except as noted)

Alloy	Silicon content, percent		Producers' stocks as of Dec. 31, 1974 r	Production		Shipments	Producers' stocks as of Dec. 31, 1975
	Range	Typical		Quantity	Silicon content [1]		
Silvery pig iron	5–24	18	W	W	W	W	W
Ferrosilicon (includes briquets)	25–55	48	23,384	463,064	222,256	377,292	55,776
Do	56–95	76	9,429	128,253	97,472	100,195	25,656
Silicon metal (excluding semiconductor grades)	96–99	98	8,367	103,036	100,975	89,328	13,799
Miscellaneous silicon alloys (excluding silicomanganese)	--	60	6,791	68,046	40,828	56,873	11,572
Other silicon alloys and products	--	45	5,230	10,167	4,575	7,984	6,273
Total [2]	--	60	53,201	772,566	466,106	631,672	113,076

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Estimated from typical value for silicon content.
[2] Exclusive of silvery pig iron.

Table 2.—Producers of silicon alloys and/or silicon metal in the United States in 1975

Producer	Plant location	Product
Airco, Inc., Airco Alloys Div	Calvert City, Ky	FeSi.
Alabama Alloy Co., Inc	Bessemer, Ala	Do.
Engelhard Minerals & Chemicals Corp., Philipp Bros. Div. Roane Electric Furnace Co	Rockwood, Tenn	Do.
Foote Mineral Co., Ferroalloys Div	Graham, W. Va	Do.
Do	Keokuk, Iowa	Silvery pig iron.
Hanna Mining Co.,		
Hanna Nickel Smelting Co	Riddle, Oreg	FeSi.
Silicon Division	Wenatchee, Wash	FeSi, Si.
Interlake, Inc., Globe Metallurgical Div	Beverly, Ohio	Do.
Do	Selma, Ala	Si.
International Minerals & Chemical Corp., Industrial Minerals Div.		
Tennessee Alloys Corp	Bridgeport, Ala	FeSi.
Tennessee Metallurgical Corp	Kimball, Tenn	Do.
Kawecki Berylco Industries, Inc. National Metallurgical Div	Springfield, Oreg	Si.
Ohio Ferro-Alloys Corp	Brilliant, Ohio	FeSi, Si.
Do	Philo, Ohio	FeSi.
Do	Powhatan, Ohio	Si.
Reynolds Metals Co	Sheffield, Ala	Do.
Union Carbide Corp., Metals Div	Alloy, W. Va	FeSi, Si.
Do	Ashtabula, Ohio	FeSi.
Do	Marietta, Ohio	Do.
Do	Portland, Oreg	Do.
Do	Sheffield, Ala	Do.

CONSUMPTION AND USES

Reported consumption of silicon materials declined generally, about one-fourth compared with 1974. A lesser decline was observed in the range including 50% ferrosilicon, while more pronounced decreases occurred for silvery pig iron, and especially for the 85% and 90% ferrosilicons. The largest demand in 1975 was for the 50% and 75% ferrosilicon grades, followed, on the basis of silicon content, by silicon metal, miscellaneous silicon alloys, and silvery pig iron. The decreasing order of end uses for silicon materials was cast iron, steel, nonferrous alloys, and silicones, with about 80% of consumption being accounted for by ferrous applications. Cast iron production consumed the greatest amounts of silvery pig iron, miscellaneous silicon alloys, and the 85% and 90% ferrosilicons, while steelmaking was the biggest user of 75% ferrosilicon. Iron foundries and steel plants together accounted for 98% of 50% ferrosilicon usage; 93% of silicon metal went into nonferrous alloys and silicones.

Decreases in consumption paralleled declines in major markets for silicon alloys and metal. Iron foundries and the steel industry each experienced production drops of about 20%. The aluminum industry, which uses silicon metal to make castings, suffered from an excess of supply over demand and reduced production. The cutback, 15% or more for domestic porducers, was partly caused by declines in the housing and transportation markets. Demand for silicon metal by the automotive and chemical industries rose in the latter part of 1975. For the first time since 1970, silicones suffered a decline overall, estimated at 5%, but a need was forseen for large increases in productive capacity by 1980. All three producers, Dow Corning Corp., General Electric Co., and Union Carbide Corp., were either already expanding productive facilities or planning to do so.

Efforts continued in developing specialty uses for silicon in high-temperature applications, in such forms as silicon nitride and silicon-silicon carbide composites, the latter prepared by infiltrating carbon filaments with liquid silicon.

Silicon metal produced by tonnage methods is used as raw material for the manufacture of the relatively small quantity of nearly pure silicon utilized for electronics and other specialized applications. The Bureau of Mines does not collect data on these specialty grades of silicon, which have a high unit value.

Consumer stocks of silicon material declined substantially from those at the end of 1974 for all but the 56% to 70% ferrosilicon range. Stocks for this range, the 71% to 80% range, and for silicon metal dropped to moderate levels, while those of other silicon materials decreased to recession levels, especially for the 81% to 95% range.

Table 3.—Consumption, by major end use, and stocks of silicon alloys and metal in the United States in 1975

(Short tons)

End use	Silvery pig iron	Ferrosilicon [1]				Silicon metal	Miscellaneous silicon alloys [2]	Total alloys and metal	Total silicon content [3]
Range	5–24% Si	25–55% Si	56–70% Si	71–80% Si	81–95% Si	96–99% Si			
Typical	18% Si	48% Si	65% Si	76% Si	85% Si	98% Si	58% Si		
Steel:									
Carbon	2,474	82,229	3,775	44,822	95	664	7,592	141,651	81,600
Stainless and heat resisting	(4)	9,101	198	8,992	75	62	365	18,793	11,700
Full alloy	449	30,474	1,139	11,382	246	1,455	1,328	46,473	26,500
High-strength low-alloy	340	7,414	(5)	2,079	(5)	(5)	779	10,612	5,600
Electric	--	149	(5)	19,422	(5)	(5)	--	19,571	14,800
Tool	--	1,511	(4)	750	(4)	(4)	(4)	2,261	1,300
Total steel [6]	3,263	130,878	5,112	87,447	416	2,181	10,064	239,361	141,500
Cast irons	61,182	179,959	2,472	32,350	2,125	24	68,689	346,801	165,300
Superalloys	5	226	8	56	85	42	2	424	300
Alloys (excluding alloy steels and superalloys)	714	4,416	3	418	356	41,941	5,604	53,452	47,200
Silicones	--	--	--	--	--	26,375	--	26,375	25,900
Miscellaneous and unspecified	3,874	8,003	25	1,296	52	2,727	5,851	16,828	9,200
Total	69,038	318,482	7,620	121,567	3,034	73,290	90,210	683,241	389,400
Percent of 1974	e 57	88	71	73	17	71	74	e 75	e 75
Total silicon content [3]	12,400	152,900	5,000	92,400	2,600	71,800	52,300	389,400	XX
Consumers stocks, Dec. 31, 1975	8,637	30,518	1,995	17,958	944	10,616	8,739	93,501	47,400

e Estimated. XX Not applicable.
[1] Includes briquets.
[2] Includes magnesium-ferrosilicon and other silicon alloys.
[3] Estimated based on typical percent content.
[4] Included with "Miscellaneous and unspecified."
[5] Included with "Full alloy steel."
[6] With exceptions as denoted by footnote 4.

Table 4.—Distribution of consumption by major end use of silicon alloys and metal in the United States in 1975

(Percent)

End use	Range	Silvery pig iron 5–24% Si	Ferrosilicon[1] 25–55% Si	56–70% Si	71–80% Si	81–95% Si	Silicon metal 96–99% Si	Miscellaneous silicon alloys[2]	Total silicon content[3]
Steel:									
Carbon		3.6	25.8	49.5	36.9	3.1	0.9	8.4	20.9
Stainless and heat-resisting		(4)	2.9	2.6	7.4	2.5	.1	.4	3.0
Full alloy		.6	9.6	15.0	9.4	8.1	2.0	1.5	6.8
High-strength low-alloy		.5	2.3	(5)	1.7	(5)	(5)	.9	1.5
Electric		--	--	(5)	16.0	(5)	(5)	--	3.8
Tool		--	.5	(4)	.6	(4)	(4)	(4)	.3
Total steel[6]		4.7	41.1	67.1	72.0	13.7	3.0	11.2	36.3
Cast irons		88.6	56.5	32.5	26.6	70.1	--	76.1	42.5
Superalloys		--	.1	.1	--	2.8	.1	--	.1
Alloys (excluding alloy steels and superalloys)		1.1	1.4	--	.3	11.7	57.2	6.2	12.1
Silicones		--	--	--	--	--	36.0	--	6.6
Miscellaneous and unspecified		5.6	.9	.3	1.1	1.7	3.7	6.5	2.4
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent of total silicon content[3]		3.2	39.3	1.3	23.7	0.7	18.4	13.4	100.0

[1] Includes briquets.
[2] Includes magnesium-ferrosilicon and other silicon alloys.
[3] Estimated based on typical content.
[4] Included with "Miscellaneous and unspecified."
[5] Included with "Full alloy steel."
[6] With exceptions as denoted by footnote 4.

PRICES

Prices of silicon materials, as quoted in Metals Week, followed the pattern observed in several other metals industries during the recession year of 1975. Because of large inventory accumulations of both domestic and imported material, prices declined throughout the year. However, U.S. producers effectively maintained prices and reduced production rather than engaging in price cutting in a weak market. Imported material, which had been selling at highly inflated prices in 1974, therefore showed the greatest price declines. Prices for imported material began the year substantially above those for domestic material, but fell rapidly close to or below domestic prices for most of the year. In March 1975, Foote Mineral Co. began giving a 6% rebate on silvery pig iron because of lower scrap iron costs.

Ferrosilicon, which is priced on the basis of silicon contained, declined only slightly in price for domestic product. The decline took place in the spring, and amounted to 3% and 5% for 50% and 75% ferrosilicon, respectively. Per pound of silicon contained, the 50% grade decreased from 33.5 to 32.5 cents and the 75% grade dropped from 38.5 to 36.5 cents. The c.i.f. price of imported 75% ferrosilicon decreased several times, declining 50% overall on the basis of the middle of the range for high and low quotes, from 55 to 70 cents to 28 to 34 cents.

Prices for domestic silicon metal, on the basis of the midrange, were lowered 13% through the year for both the 0.35% and 1% maximum iron grades; the former from 46.5 to 59.9 cents to 46.4 cents per pound and the latter from 42.25 to 55 cents to 42.25 cents per pound. Also on the basis of the midrange, imported silicon metal (c.i.f. price, grade not specified) decreased 33%, from 55 to 75 cents to 42.5 to 44.5 cents per pound.

FOREIGN TRADE

Exports of ferrosilicon were the highest in terms of value ever, and second in quantity only to those in 1970. The largest amounts were exported to Canada and Sweden, 21,498 and 9,164 tons, respectively, which together accounted for about 80% of both total quantity and value. Exports, which included silicomanganese, went to 22 countries. Data specific to exports of silicon metal were not available.

Compared with 1974, imports dropped 51% in volume and 37% in value for ferrosilicon overall, and 35% in volume and 61% in value for silicon metal. Imports in relation to U.S. production and reported consumption were at a significant level for 75% ferrosilicon and for ferrosilicon containing 80% or more silicon. Imports of 75% ferrosilicon were the most significant on a volume basis, amounting to about two-fifths of reported consumption and of domestic production.

The 75% grade of ferrosilicon accounted for more than three-fourths of ferrosilicon imports. Norway shipped about one-half the total 60% to 80% silicon range while Canada, Japan, and Sweden, each with about one-tenth of the total, were the next largest sources. Imports in this range from Sweden, France, and Yugoslavia declined notably compared with 1974. The next largest import class was that for 8% to 60% silicon, which comprised more than one-fifth of ferrosilicon imports. The three main sources within that class were Japan and France for 50% ferrosilicon, and Canada for ferrosilicons averaging about 30% silicon. Average silicon content of all imported ferrosilicon rose again to 67%. The Republic of South Africa and Norway were the dominant identifiable sources of commercial-purity silicon metal, as South Africa, in its first year as a metal producer, shipped the most to the United States.

The marked increase in exports and decline in imports did not change the U.S. position as a net importer of ferrosilicon. Net imports amounted to almost 32 million tons and a trade deficit of about $27 million.

Table 5.—U.S. exports of ferrosilicon

Year	Quantity (short tons)	Value (thousands)
1973	15,984	$4,051
1974	6,575	3,338
1975	38,452	15,281

Table 6.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country

Grade and country	1973			1974			1975		
	Quantity (short tons)		Value (thousands)	Quantity (short tons)		Value (thousands)	Quantity (short tons)		Value (thousands)
	Gross weight	Silicon content		Gross weight	Silicon content		Gross weight	Silicon content	
Ferrosilicon:									
Over 8% but not over 60% silicon:									
Belgium-Luxembourg	--	--	--	19	9	$15	64	29	$56
Canada	16,005	3,474	$1,153	20,350	4,205	1,786	6,291	1,866	1,105
Denmark	1,051	467	349	661	295	208	--	--	--
France	2,820	1,522	1,104	4,278	2,367	2,360	2,863	1,450	2,211
Germany, West	282	145	167	332	170	245	284	154	528
Italy	--	--	--	190	87	72	38	18	14
Japan	1,379	658	469	875	399	640	4,318	2,027	4,021
Mexico	--	--	--	948	454	336	--	--	--
Norway	1,485	659	471	907	404	546	1,451	634	1,059
South Africa, Republic of	1,299	492	104	--	--	--			
Spain	--	--	--	78	39	19	--	--	--
Sweden	--	--	--	99	44	37	--	--	--
United Kingdom	--	--	--	25	7	5	20	4	16
Total	24,321	7,417	3,817	28,762	8,480	6,269	15,329	6,182	9,010

See footnotes at end of table.

Table 6.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country—Continued

Grade and country	1973 Quantity (short tons) Gross weight	1973 Quantity (short tons) Silicon content	1973 Value (thousands)	1974 Quantity (short tons) Gross weight	1974 Quantity (short tons) Silicon content	1974 Value (thousands)	1975 Quantity (short tons) Gross weight	1975 Quantity (short tons) Silicon content	1975 Value (thousands)
Ferrosilicon—Continued:									
Over 60% but not over 80% silicon:									
Belgium-Luxembourg	36	22	$15	217	170	$177	--	--	--
Brazil	350	263	71	3,254	2,483	2,194	342	256	$237
Canada	2,971	2,240	757	4,977	3,707	1,937	5,980	4,534	3,407
Egypt	--	--	--	716	534	856	--	--	--
France	8,025	4,915	3,368	10,278	6,468	6,327	2,415	1,540	2,195
Germany, West	101	67	56	1,515	1,097	678	362	239	444
Greece	2,773	2,110	536	--	--	--	--	--	--
India	--	--	--	2,300	1,710	499	1,098	824	1,145
Italy	--	--	--	320	244	182	--	--	--
Japan	2	1	1	7,043	5,389	7,436	4,675	3,557	4,155
Korea, Republic of	--	--	--	568	443	355	298	225	269
Mexico	--	--	--	405	304	323	--	--	--
Netherlands	854	635	156	520	r 393	169	585	418	328
Norway	37,818	28,565	6,884	26,966	20,297	9,399	27,689	20,685	13,188
Poland	--	--	--	255	196	112	--	--	--
Portugal	--	--	--	1,012	772	771	549	415	276
Sierre Leone	--	--	--	22	16	30	--	--	--
South Africa, Republic of	614	470	152	3,394	2,558	1,950	176	138	154
Spain	771	578	127	9,742	7,359	6,612	661	520	751
Sweden	15,622	11,599	3,953	23,107	17,315	9,314	4,519	3,389	1,857
Switzerland	--	--	--	110	87	101	--	--	--
Taiwan	--	--	--	3,149	2,342	2,532	3,964	2,976	2,780
Thailand	--	--	--	160	121	98	83	61	55
U.S.S.R	110	87	60	677	527	706	--	--	--
United Kingdom	--	--	--	236	178	123	--	--	--
Yugoslavia	5,566	4,264	1,237	11,613	8,906	6,424	630	488	759
Total	75,613	55,816	17,373	112,556	r 83,616	59,305	54,026	40,265	32,000
Over 80% but not over 90% silicon:									
Canada	369	319	39	101	86	43	88	71	52
Japan	--	--	--	--	--	--	221	183	267
Portugal	--	--	--	--	--	--	56	50	70
South Africa, Republic of	27	24	8	--	--	--	--	--	--
Switzerland	--	--	--	110	89	61	--	--	--
United Kingdom	--	--	--	58	52	51	278	232	249
Vietnam, South	--	--	--	--	--	--	182	146	126
Yugoslavia	--	--	--	20	16	10	--	--	--
Total	396	343	47	289	243	165	825	682	764
Over 90% silicon content:									
Belgium-Luxembourg	--	--	--	274	r 257	281	--	--	--
France	--	--	--	--	--	--	40	39	25
Japan [1]	112	110	60	--	--	--	--	--	--
Netherlands	--	--	--	r 328	r 304	r 225	217	197	151
Poland	--	--	--	108	102	74	--	--	--
Sweden	39	38	19	--	--	--	--	--	--
Switzerland	--	--	--	r 16	15	21	--	--	--
Yugoslavia	--	--	--	116	114	161	--	--	--
Total	151	148	79	r 842	r 792	r 762	257	236	176
Grand total	100,481	63,724	21,316	r 142,449	r 93,131	r 66,501	70,437	47,365	41,950
Silicon metal:									
Not over 99.7% silicon:									
Belgium-Luxembourg	92	91	44	152	149	93	--	--	--
Canada	259	256	112	3	2	2	--	--	--
France	1,125	1,099	499	304	301	133	--	--	--

See footnotes at end of table.

Table 6.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country—Continued

Grade and country	1973 Quantity (short tons) Gross weight	1973 Quantity (short tons) Silicon content	1973 Value (thousands)	1974 Quantity (short tons) Gross weight	1974 Quantity (short tons) Silicon content	1974 Value (thousands)	1975 Quantity (short tons) Gross weight	1975 Quantity (short tons) Silicon content	1975 Value (thousands)
Silicon metal—Continued:									
Not over 99.7% silicon—Continued:									
Germany, West	18	17	$11	--	--	--	--	--	--
Japan	248	244	107	60	57	$99	--	--	--
Netherlands	816	808	440	203	185	356	--	--	--
Norway	2,784	2,747	1,156	2,499	2,464	1,939	1,816	1,298	$1,080
Portugal	--	--	--	33	32	14	--	--	--
South Africa, Republic of	--	--	--	--	--	--	1,878	1,846	1,153
Spain	55	54	37	--	--	--	--	--	--
Sweden	20	19	9	--	--	--	--	--	--
Switzerland	384	379	207	--	--	--	--	--	--
Taiwan	--	--	--	313	311	480	--	--	--
United Kingdom	755	748	398	66	65	77	--	--	--
Yugoslavia	1,656	1,396	617	1,875	1,856	2,616	516	510	472
Total	8,212	7,858	3,637	5,508	5,422	5,809	3,710	3,654	2,705
Over 99.7% silicon:									
Belgium-Luxembourg	1	1	142	1	1	96	(1)	(1)	13
Canada	21	21	15	1	1	4	(1)	(1)	5
Czechoslovakia	--	--	--	--	--	--	56	56	70
Denmark	1	1	79	2	2	347	(1)	(1)	134
France	108	108	125	60	60	150	--	--	--
Germany, West	81	81	7,012	87	87	6,639	30	30	2,054
Italy	--	--	--	3	3	263	1	1	43
Japan	12	12	819	57	57	2,982	15	15	1,145
Netherlands	220	220	115	--	--	--	--	--	--
Norway	--	--	--	111	111	87	95	95	136
Portugal	--	--	--	43	43	48	--	--	--
Switzerland	--	--	--	--	--	--	1	1	270
U.S.S.R	--	--	--	(1)	(1)	130	--	--	--
United Kingdom	(1)	(1)	11	--	--	--	(1)	(1)	16
Yugoslavia	--	--	--	127	127	145	--	--	--
Total	444	444	8,318	492	492	10,891	198	198	3,886
Grand total	8,656	8,302	11,955	6,000	5,914	16,700	3,908	3,852	6,591

r Revised.
1 Less than ½ unit.

WORLD REVIEW

Expansions of ferrosilicon and silicon metal production facilities either carried out or projected for the near future were at least comparable in total with those in the United States. In some countries, expansion appeared to be forestalled by concern about effects on the environment of the smelting facilities or the powerplants required to furnish additional electrical energy.

Australia.—A new 45-MVA ferrosilicon furnace will allow Broken Hill Proprietary Co. Ltd. (BHP) to produce rather than import its ferrosilicon needs. The furnace, of Norwegian design, was part of an expansion at the Bell Bay, Tasmania, plant of the Tasmanian Electrometallurgical Co. Pty. Ltd. (TEMCO), a BHP subsidiary. The plant, whose ferromanganese and silicomanganese production also increased, will be fed an additional 50,000 annual tons of local Tasmanian quartzite. About half of the increase in ferrosilicon manufacture will be available for export.

Other plans for new ferrosilicon production in excess of 50,000 annual tons at Electrona, Tasmania, were dropped, partly because of inflated costs. A plant was planned to be built in place of an existing carbide facility. Consolidated Gold Fields Australia Ltd. was a leading member of a consortium formed for the project, which at one point had attracted Norwegian interests.

Canada.—Late in the year Chromasco Ltd. began operation at Beauharnois, Quebec of a new ferrosilicon furnace of its own design and manufacture. The furnace, mainly for 50% ferrosilicon, is a 24-megawatt unit with a production capacity of about 30,000 annual tons.

Construction began in June at Becancour, Quebec on a ferrosilicon and silicon metal plant by SKW Electro-Metallurgy Canada Ltd. (SKW-Canada). The plant was scheduled to begin producing in the first part of 1976 about 60,000 annual tons to be divided about equally between ferrosilicon and metal. The plant will take advantage of hydropower and deep sea port facilities, and annually consume 130,000 tons of quartz. SKW-Canada is 85% owned by Suddeutsche Kalkstickstoff-Werke AG, Trostberg, West Germany, and 15% by A/S Ila og Lilleby Smelteverker, Trondheim, Norway, both ferroalloy producers.

Iceland.—Icelandic Alloys Ltd., a joint undertaking between the Government of Iceland and Union Carbide Corp., began building a plant on the southwest coast for production of about 50,000 annual tons of 75% ferrosilicon. The company was established on April 28, 1975, following parliamentary approval and more than 3 years of preparatory work. Financing of a total capital investment of about $70 million was to be 55% by the Government and 45% by Union Carbide. This is one of several projects envisioned by the Government to utilize hydroelectric resources under development. The company was to operate under terms similar to those accorded other comparable export industries. Union Carbide was to market the product mainly for sale to Europe.

Construction was originally scheduled for completion in 1977–78. The plant is located at Grundartangi on Hvalfjordhur, a short distance north of Reykjavik, at a latitude roughly that of Trondheim, Norway. The plant was expected to use about one-third the output of the 150-MW Sigalda hydroelectric project, a new State-owned power station being built.

Japan.—Japanese producers began the year seeking methods of assuring supplies of silicon materials at reasonable prices in the face of domestic productive capability about equal to demand. Contracting on a long-term basis between producer and consumer cartels was judged an effective way of stabilizing supplies and prices. However, as the year progressed, steel production and silicon requirements declined sharply. Ferrosilicon and silicon metal producers were forced to sell in the home market below cost, while reducing production to half or less of capacity. The revised estimate for ferrosilicon production in fiscal 1975 was 338,000 tons. Nevertheless, late in the year Ube Denki Kagaku began operating a 40-MVA ferrosilicon furnace rated at 33,000 annual tons at Ube.

Korea, South.—A 28-MVA ferrosilicon furnace was started up in midyear by the Inchon Ferro-Alloy Co., a joint venture between the State steel company (Inchon Iron & Steel Co., Ltd.) and Japanese firms (Joetsu Denro Kogyo and Mitsui & Co., Ltd.). Building of the plant began in the latter part of 1974, production from which is expected to exceed 10,000 annual tons.

Philippines.—Electro Alloys Corp., the first overseas manufacturing project of Japanese ferrosilicon producers, moved ahead towards beginning production in 1976. In midyear construction began on Mindanao of a ferrosilicon furnace rated at 13,700 annual tons. The Philippine Laurel Co. owns 60% of Electro Alloys, while the balance of ownership is equally divided by the Japanese firms, Nippon Denko Co., Ltd. and C. Itoh & Co., Ltd. Output is expected to go mainly to Japan. Maria Cristina Chemical Industries (MCCI) began ferrosilicon production from a 21-MVA unit on Mindanao in the latter half of 1975. MCCI also financed 60% of a new company (Mindanao Alloy Corp.) to produce ferrosilicon. Japanese interests provided the rest of the investment. Installation of two 25-MVA furnaces was projected to give a production capacity of 30,000 annual tons by late 1977.

South Africa, Republic of.—Silicon Smelters (Pty.) Ltd. brought all three 25-MVA silicon metal furnaces into operation at its $30 million plant near Pietersburg, about 150 miles northeast of Pretoria. These Elkem units have already produced above the nominal capacity of 33,000 annual tons, although not yet on a sustained basis. Output from this plant is able to meet all present and foreseeable South African silicon metal requirements. Presently about 95% of the output is to be exported, one of the largest customers being the Aluminum Co. of Canada, Ltd. (Alcan), one of the three owners of Silicon Smelters.

U.S.S.R.—Western technical and financial assistance, including that of U.S. ferroalloy producers, was sought for a 60,000-annual-ton silicon metal plant to be located in Siberia. Negotiations have been underway since the latter part of 1974 for this and other ferroalloy and aluminum plants projected to be completed in 1980. Products of the new plants are likely to be consumed within the U.S.S.R. and neighboring Eastern bloc countries.

Venezuela.—Two projects, which between them would ultimately lead to annual production of 100,000 tons of ferrosilicon, fell behind or were delayed beyond the original timetable. Production from the first of three units of a joint project between the Government and Sumitomo Shoji Kaisha (Japan) was anticipated in 1976, with projections of final capacity of 50,000 annual tons in 1978. A 1-year delay developed for the Venbozel joint venture, and plans for attaining a production level also of about 50,000 annual tons were moved back to 1978. The Venbozel project, begun as a joint effort between the French company Nobel Bozel S.A. and the Venezuelan Corp. of Guyana (CVG), attracted Japanese interests for participation in constructing a third furnace. Scheduled production from the first furnace at Mantanzas was delayed until 1977.

Silver

By Harold J. Drake [1]

Domestic mine production of silver in 1975 totaled 34.9 million troy ounces compared with 33.8 million troy ounces in 1974. The increase was accounted for mainly in metal from silver ore mining operations. Mine production of silver in Idaho rose 12%, while that in Arizona fell 1%. These two States accounted for 58% of the total output in 1975. Other States reporting increased production included Colorado, 21%; Missouri, 6%, and Nevada, 84%. Declines were reported for Michigan 2%, Montana 25%, New Mexico 34%, and Utah 12%.

Production of marketable silver at refineries, which used foreign and domestic concentrates and ores and scrap feed material, totaled 109.7 million troy ounces compared with 119.4 million troy ounces in 1974. A 4-million troy ounce decline in silver production from imported concentrates and ores and a 9-million troy ounce decline in silver output from coins was not offset by increases in refinery output from other materials. Silver from scrap produced and recycled at refineries totaled 50.5 million ounces, a level only slightly higher than that of 1974.

Consumption of silver declined 9% to 160.4 million troy ounces. Industrial use was off 10% whereas coinage use nearly tripled.

On January 2, 1975, the average price was 427.0 cents per ounce, and on December 31, 1975, the average price was 416.5 cents per ounce. The year high of 522.5 cents per ounce was reached on August 7, and the year low of 391.0 cents per ounce on December 15. The average price in 1975 was 441.8 cents per ounce compared with 470.8 cents per ounce in 1974.

U.S. imports of silver totaled 90.4 million ounces, a level well below the 133.4 million ounces imported in 1974. Exports, in contrast, rose 77% to 32.6 million ounces.

Industry stocks at yearend totaled 34.6 million ounces, a decrease of 14.7 million ounces from 1974. Treasury bullion stocks in the Bureau of the Mint were reduced by 3.0 million ounces to 41.0 million ounces. Department of Defense stocks available to defense contractors were 8 million ounces. The total amount of silver in the national stockpile remained at 139.5 million ounces with 117.8 million ounces available for disposal. Congressional approval is required for disposal of silver from the national stockpile and in 1975 it was not given.

Trading volume on the New York Commodity Exchange (COMEX) increased 36% over 1974. The Chicago Board of Trade (CBOT) trading volume increased 34% over 1974. COMEX warehouse stocks increased 26% in 1975, while CBOT stocks nearly doubled.

World mine production of silver totaled 294.3 million ounces compared with 294.9 million ounces in 1974.

Legislation and Government Programs.—Silver remained eligible for exploration assistance of up to 75% of approved costs under a program conducted by the Office of Minerals Exploration, U.S. Geological Survey. No loans were made in 1975.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient silver statistics

	1971	1972	1973	1974	1975
United States:					
Mine production - thousand troy ounces --	41,564	37,233	37,484	33,762	34,938
Value ---------------- thousands --	$64,258	$62,737	$95,883	$159,018	$154,424
Ore (dry and siliceous) produced:					
Gold ore ------ thousand short tons --	1,872	1,579	3,817	2,033	2,251
Gold-silver ore --------------- do ----	167	173	124	65	137
Silver ore ------------------ do ----	683	564	593	698	782
Percentage derived from:					
Dry and siliceous ores ----------------	37	31	30	30	35
Base metal ores ----------------------	63	69	70	70	65
Refinery production [1] thousand troy ounces --	37,242	38,366	36,494	32,368	33,073
Exports [2] ---------------------- do ----	12,224	29,657	11,215	18,390	32,626
Imports, general [2] -------------- do ----	57,962	65,406	130,681	133,896	90,422
Stocks Dec. 31:					
Treasury [3] ----- million troy ounces --	48	46	45	44	41
Industry [4] --- thousand troy ounces --	185,335	152,255	130,111	r 136,543	158,818
Consumption:					
Industry and the arts -------- do ----	129,146	151,663	196,386	r 176,027	157,650
Coinage ---------------------- do ----	2,474	2,284	920	1,017	2,740
Price [5] --------------- per troy ounce --	$1.546	$1.685	$2.558	$4.708	$4.418
World:					
Production ------ thousand troy ounces --	294,713	301,510	r 307,974	r 294,935	294,268
Consumption [6]:					
Industry and the arts -------- do ----	351,400	388,300	r 472,000	r 426,900	355,000
Coinage --------------------- do ----	r 28,300	r 38,400	r 23,700	33,000	35,000

r Revised.
[1] From domestic ores.
[2] Excludes coinage.
[3] Excludes silver in silver dollars.
[4] Includes silver in COMEX warehouses and silver registered in CBOT warehouses.
[5] Average New York price—Source: Handy & Harman.
[6] Market economies only—Source: Handy & Harman.

DOMESTIC PRODUCTION

Domestic mine production of recoverable silver increased slightly to 34.9 million ounces. This level of production provided 22% of U.S. demand in 1975. Idaho accounted for 40% of the output, Arizona 18%, and Colorado 10%. Missouri, Montana, Nevada, and Utah, in the aggregate, accounted for 27%, and 14 other States accounted for the remainder. About 35% of the silver came from copper mining operations, 33% from silver ore, 15% from lead ore, and 14% from copper-lead-zinc ores. The remainder came from ores of gold, gold-silver, or zinc, and from old tailings.

Refinery production of marketable silver totaled 109.7 million ounces, 55% of which came from concentrates and ores, both foreign and domestic, with the remainder coming from old scrap. Recovery from domestic ores and concentrates rose about 2%, whereas recovery from imported ores and concentrates, continuing a decline begun in 1973, dropped 13%. Production of silver from coins retreated sharply from the very high levels of 1974 and was the reason for a 12% drop to 49.6 million ounces of silver extracted from old scrap. Production from new scrap, 50.5 million ounces, was only slightly above that of 1974.

The 25 leading silver producers (table 3) accounted for 81% of domestic production. Four of the leading producers mined silver ores, while most of the remainder mined copper, lead, and zinc ores. Nine of the leading mines produced in excess of 1 million ounces each during the year.

Hecla Mining Co., Wallace, Idaho, reported production of 4.2 million ounces of silver in metallic concentrates in 1975.[2] Hecla's Lucky Friday mine accounted for three-fifths of this output, and the company's share of the Sunshine Unit area for one-third. Hecla's share of the Star-Morning Unit area accounted for the remainder. The Lucky Friday mine produced 2.54

[2] Hecla Mining Co. 1975 Annual Report. 28 pp.

million ounces of silver from 173,245 tons of ore averaging 14.67 ounces of silver per ton. Both tonnage and grade were higher in 1975 than in 1974. Hecla's share of the Sunshine Unit area totaled 1.44 million ounces from 62,034 tons of ore averaging 23.14 ounces of silver per ton. A tonnage increase in 1975 was accompanied by about a one-half ounce decline in grade.

Production of silver from the Galena mine by ASARCO Incorporated totaled 3.35 million ounces, a slight decline from that of 1974.[3] ASARCO reported the completion of its new Coeur silver mine in Idaho with a capacity to produce concentrates containing 2.2 million ounces of silver per year. Production was scheduled for 1976. Construction of the Ontario mine, Park City, Utah, was completed. The mine, in which ASARCO has a 40% interest, has the capacity to produce 1.2 million ounces of silver per year.

Production of silver by The Bunker Hill Co., a subsidiary of Gulf Resources & Chemical Corp., rose 3% to 6.98 million ounces.[4] Most of the company's silver production came from the Bunker Hill mine which ranked as the eighth largest producer in 1975, and the Crescent mine which ranked as the eleventh largest silver producing mine.

The Anaconda Company reported that production of byproduct silver at its Berkeley pit in Montana totaled 2.35 million ounces, down sharply from the 3.57 million ounces produced in 1974.[5] Adverse economic conditions continued in 1975, and resulted in sharply curtailed copper mining by Anaconda which, in turn, led to curtailed silver production. The Berkeley pit was the fourth largest silver producer in 1975.

Production at the Sunshine mine totaled 5.13 million ounces, an increase of 1.28 million ounces over that of 1974. The Sunshine Mining Co. operated the mine and distributed part of the output to Hecla Mining Co. The Sunshine mine was the largest silver producer in 1975.

A new silver scrap plant with a daily productive capacity of 40,000 ounces of silver was completed.[6] Using a hydrometallurgical extraction process, the plant will produce silver that meets anode, nitrate, and photographic standards.

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[3] ASARCO Incorporated. 1975 Annual Report. 32 pp.

[4] Gulf Resources & Chemical Corp. 1975 Annual Report. 36 pp.

[5] The Anaconda Company. 1975 Annual Report. 39 pp.

[6] American Metal Market. Silvachem Completes New Scrap Plant. V. 82, No. 63, April 1975, p. 6.

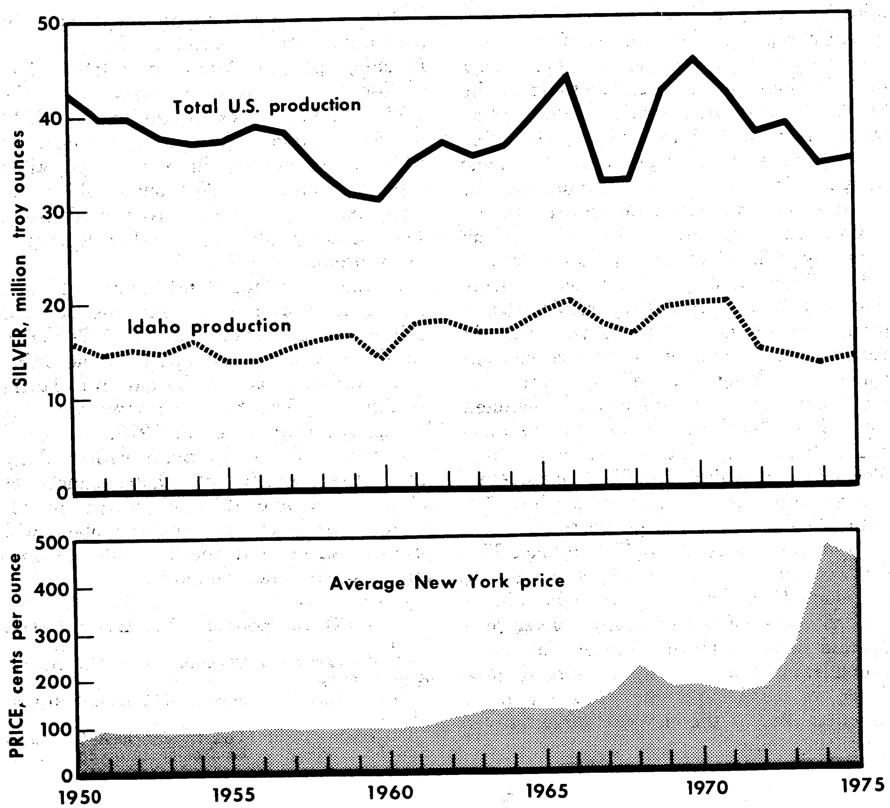

Figure 1.—Silver production in the United States and Idaho and price per ounce.

CONSUMPTION AND USES

Consumption of silver in 1975 declined 9% to 160.4 million ounces reflecting the generally poor economic conditions in the United States during most of the year. Contributing to the decline in consumption were high silver prices, more internal recycling, and substitution of lower cost materials for silver.

Consumption of silver in photographic materials, the largest use category, declined 7% to 46.1 million ounces. The photographic industry increased the use of non-silver photographic processes, and also increased the recycling of silver. Use of silver in contacts and conductors in electrical and electronic products declined 13% to 27.2 million ounces. Consumption in coins, medallions, and commemorative objects in 1975, 7.2 million ounces, was one-third of that reported in 1974.

Compared with 1974, consumption in electroplated ware declined 4.5 million ounces (34%), dental and medical supplies 0.9 million ounces (37%), brazing alloys and solders 0.9 million ounces (6%), and mirrors 0.8 million ounces (20%).

The most significant use category, in terms of quantity, reporting an increase in consumption was jewelry which used 7.6 million ounces more in 1975 than in 1974. Jewelry use in 1975 totaled 12.7 million ounces. Use in sterling ware was up 1.6 million ounces to 23.7 million ounces. Use of silver in catalysts rose 1.5 million ounces to 8.8 million ounces. Minor uses reporting increased consumption were batteries and bearings. Silver use in coinage, which accounted for 2% of total consumption in 1975, rose to 2.7 million ounces, compared with 1.0 million ounces in 1974.

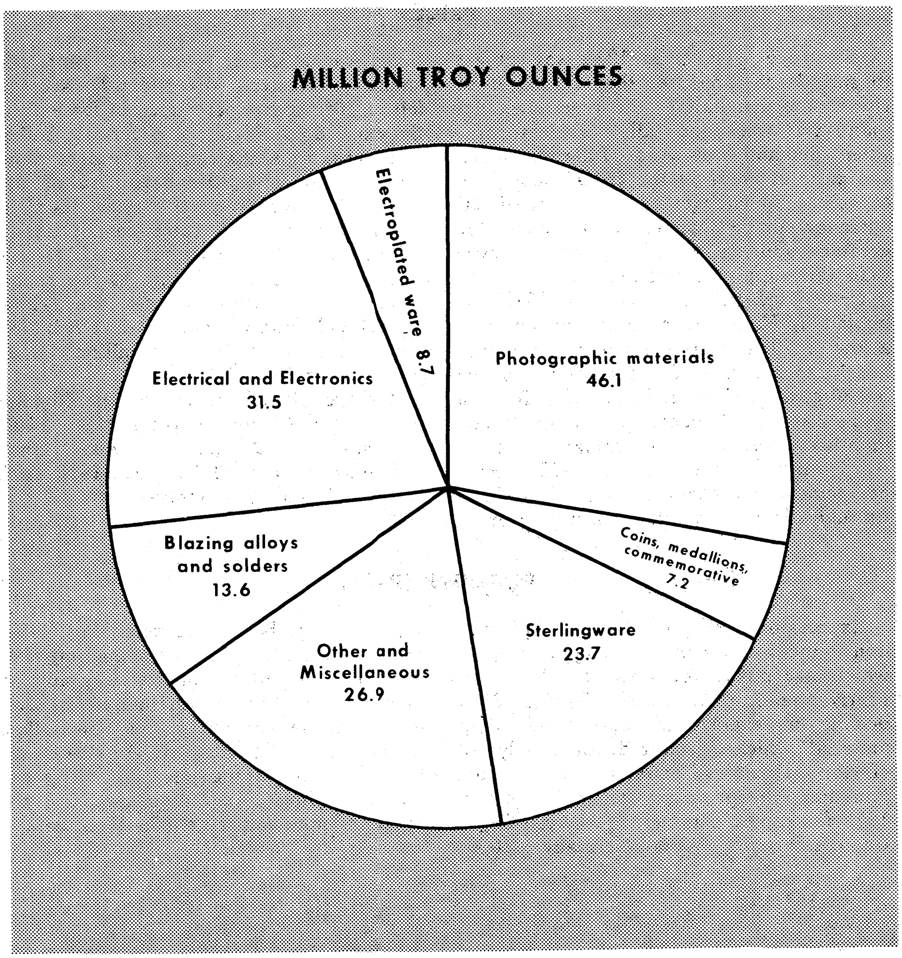

Figure 2.—Silver consumption in the United States, 1975.

STOCKS

Total yearend stocks of silver were, exclusive of the strategic stockpile, 207.8 million ounces compared with 186.7 million ounces at yearend 1974. By yearend 1975, industry stocks had been reduced 14.7 million ounces to 34.6 million ounces. Another 3 million ounces were disposed of as Treasury bullion stocks were reduced to 41.0 million ounces consisting of bullion, coin bars, and coinage metal fund silver. Stocks in registered vaults of COMEX rose by 17.9 million ounces to 85.7 million ounces, whereas stocks in vaults of the CBOT nearly doubled to 38.5 million ounces. Department of Defense stocks at 8 million ounces were a third higher than at yearend 1974. No action was taken by Congress to authorize disposal of the 117.8 million ounce excess portion of the 139.5 million ounces held in the strategic stockpile.

PRICES

The price of silver in 1975 was subject to speculative pressures that caused it to rise in the first half of the year when demand was weak and fall in later months when demand improved. Inflation fears, the price of grain on the CBOT, the price of gold, and changes in the international currency market appeared to have far greater influence on the price of silver than did supply and demand.

New York silver prices in 1975, as quoted by Handy & Harman, ranged from a low of 391.0 cents per ounce on December 15 to a high of 522.5 cents per ounce on August 7. The average price for the year was 441.8 cents per ounce. The monthly average from January through April ranged from 419.2 to 435.7 cents per ounce. For the next 5 months, May through September, the monthly average range was 448.9 cents to 492.5 cents per ounce. Thereafter, the monthly average fell to 408.5 cents per ounce in December. By yearend, the price of silver had fallen 10.5 cents to 416.5 cents per ounce from that prevailing at the beginning of the year. The fall from the year high in August amounted to 106.0 cents.

Trading volume on the COMEX was 14.5 billion ounces during 1975, an increase of 3.9 billion ounces over 1974. The CBOT trading volume was 9.8 billion ounces, an increase of 2.5 billion ounces over that in 1974.

Average monthly prices on the London Silver Market ranged from 409.0 cents per ounce in December to 493.5 cents per ounce in July. The average 1975 price was 444.2 cents per ounce.

FOREIGN TRADE

Exports of silver rose 77% to 32.6 million ounces. Exports of refined bullion, which accounted for 69% of the total, nearly quadrupled and offset a 21% decline in exports of waste and scrap material which accounted for nearly all of the remaining exports. The United Kingdom, the principal foreign market in 1975 for exported material, received 59%; Canada, 10%; West Germany, 10%; Japan, 9%; Belgium-Luxembourg, 5%; and Switzerland 4%. The remaining 3% went to 10 countries. Bullion was shipped mainly to the United Kingdom, West Germany, and Japan. The decrease in bullion imported by Canada in 1975 was attributed to declining need for silver for use in sterling coins commemorating the 1976 Olympic games held in Montreal.

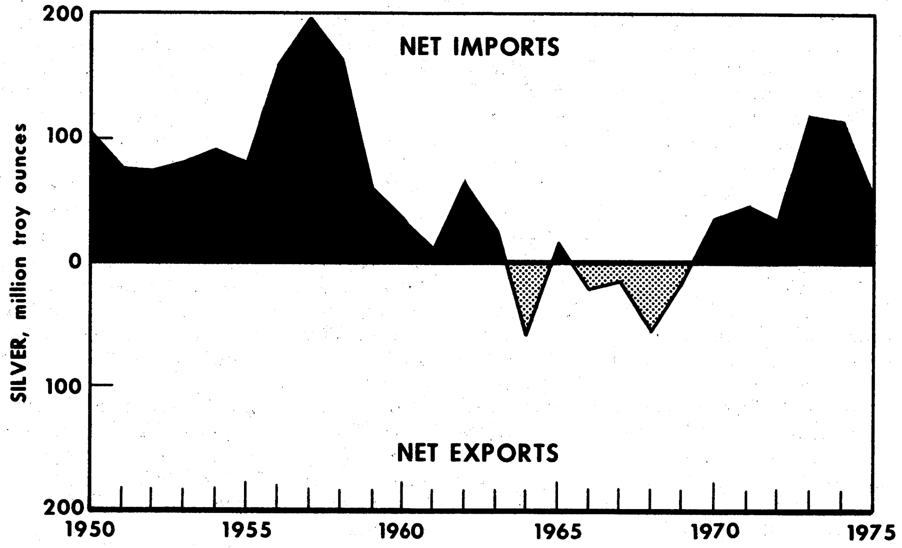

Figure 3.—Net exports or imports of silver, 1950–75.

Imports of silver totaled 90.4 million ounces compared with 133.4 million ounces in 1974. Refined bullion accounted for 68% of total imports; ore and concentrates, 23%; waste and scrap, 6%; and dore and precipitates the remainder. Imports in each of these import classes declined with bullion off 31%, and ores and concentrates off 39%. The principal source for imported silver in 1975 was Canada which supplied 34.3 million ounces equivalent to 38% of total imports. Mexico supplied 21.4 million ounces or 24% of total imports, and Peru supplied 17.7 million ounces or 20% of total imports. Australia, Honduras, Japan, and Yugoslavia, in the aggregate, supplied 14.0 million ounces or 15% of total imports. The remaining 3% was supplied by a number of countries including Chile, Southwest Africa, West Germany, the Philippines, and the Republic of South Africa. Most of the bullion imported in 1975 came from Canada, Mexico, and Peru. Ore and concentrates came mainly from Canada, Peru, Australia, Honduras, Mexico, and Southwest Africa. Canada accounted for most of the imported waste and scrap.

WORLD REVIEW

World mine production of silver in 1975, including centrally planned economy countries, declined 0.2% to 294.3 million ounces, as worldwide demand declined. The United States, Canada, Mexico, and Peru accounted for 51% of world output.

World consumption of silver in 1975 for industrial and coinage uses, exclusive of centrally planned economy countries, totaled 390.0 million ounces compared with 459.9 million ounces in 1974.[7] A 6% increase in use in coins was offset by a 17% decline in industrial use which accounted for 91% of total usage in 1975. Total consumption by market economy countries exceeded newly mined supply by 155.0 million ounces, according to Handy & Harman estimates. Secondary production supplied 45% of the difference, Indian stocks, 34%; demonetized coin, 13%; and U.S. and foreign governmental stocks, the remainder.

Australia.—Production of silver rose 8% to 23.5 million ounces. Development of

[7] Handy & Harman. The Silver Market, 1975. 60th Annual Review. 1975, 22 pp.

Mount Isa Mines, Ltd.'s, McArthur River lead-silver-zinc deposit in the Northern Territory, continued with the completion of underground access work and the 55-ton-per-day pilot plant. By yearend, it was reported that the deposit contained 315.0 million ounces of silver, but a satisfactory metallurgical process for extraction had not been developed. The main shaft of the company's new Hilton lead-zinc-silver mine was completed and equipped.

Canada.—Mine production of silver in 1975 declined 9% to 39.1 million ounces. Production of silver at the Kidd Creek mine of Texasgulf Canada Ltd. was 9.2 million ounces, about 12% below that of 1974.[8] At yearend, the mine contained an estimated 198.7 million ounces of silver above the 2,800-foot level. Diamond drilling in 1975, below the 2,800-foot level to delineate the ultimate depth of the ore deposit, continued to intersect ore. Texasgulf Inc. continued diamond drilling of its large base metal sulfide deposits at Izok Lake and Hood River, Northwest Territories. At yearend, the limited exploration had indicated 7 million tons of copper-zinc-lead ore containing 13 million ounces of silver at Izok Lake, and 820,000 tons of copper-zinc ore containing 0.7 million ounces of silver at Hood River. Further drilling was planned to determine the extent of both deposits.

Mine production of silver by United Keno Hill Mines, Ltd., declined 10% to 2.9 million ounces.[9] Ore reserves declined from 222,000 tons averaging 42 ounces of silver per ton to 208,000 tons averaging 37 ounces per ton. Production of silver at the new Sturgeon Lake mine, a joint venture between Sturgeon Lake Mines, Ltd., and Falconbridge Copper Ltd., was 0.977 million ounces from an ore reserve, at yearend 1975, of 1.8 million tons averaging 5.66 ounces of silver per ton.[10]

Seaforth Mines Ltd. began diamond drilling of the Porter Idaho silver property, near Stewart, British Columbia, which consists of three lode deposits, the Silverado, the Prosperity, and the Porter Idaho.[11] Very high gold and silver values per ton were reported from preliminary exploration in the Bathurst area of New Brunswick.[12] Gold values ranged from 19 ounces per ton to 32 ounces per ton, and silver values from 73 ounces per ton to 136 ounces per ton.

Production of silver from mines 12 and 6 of Brunswick Mining & Smelting Corp., Ltd., was 4.4 million ounces compared with 2.9 million ounces in 1974.[13] Reserves at both mines totaled about 100 million tons containing about 274 million ounces of silver. The Geco Division of Noranda Mines Ltd. reported production of 1.7 million ounces of silver in 1975. Ore reserves reportedly contained 42.7 million ounces of silver. Production of silver by Mattagami Lake Mines Ltd. and Mattabi Mines Ltd., with which Noranda had operating interests, totaled 2.4 million ounces. The silver content of the ore reserves of these mines totaled 36.2 million ounces.

Dominican Republic.—Rosario Dominicana, S.A., a subsidiary of Rosario Resources Corp., opened its new Pueblo Viejo base metal mine in June 1975.[14] Production of dore bullion included 109,465 ounces of silver and 195,941 ounces of gold. Reserves of oxide ore totaled 29.2 million tons containing 20 million ounces of silver and 3.7 million ounces of gold. An additional sulfide ore reserve of 21.1 million tons contained 17.7 million ounces of silver and 2.4 million ounces of gold. Development of the sulfide ore was contingent on development of a satisfactory metallurgical process to treat the ore.

El Salvador.—Agreement was reportedly reached between Canadian Javelin Ltd. and the Government for compensation to Javelin for mineral rights and assets of the Cerro Colorado silver-bearing copper deposits discovered by Javelin. Javelin continued to operate through a subsidiary, Minas San Cristobal, S.A., a gold-silver mine in El Salvador.

Honduras.—Production of silver in 1975 at the El Mochito mine of Rosario Resources Corp. totaled 3.5 million ounces compared with 3.7 million ounces in 1974. Ore reserves were increased during the year to 6.3 million tons containing 32.9 million ounces of silver and 18,970 ounces of gold. The reserves also contain lead, zinc, and copper.

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8 Texasgulf Inc. 1975 Annual Report. 48 pp.
9 Falconbridge Nickel Mines, Ltd. 1975 Annual Report. 32 pp.
10 Page 28 of reference cited in footnote 9.
11 Northern Miner. Seaforth to Drill Silver Prospect. V. 61, No. 22, Aug. 14, 1975, p. 21.
12 Northern Miner. New Bathhurst Area Discovery Runs High in Gold and Silver. V. 61, No. 27, Sept. 18, 1975, pp. 1, 12.
13 Noranda Mines Ltd. 1975 Annual Report. 40 pp.
14 Rosario Resources Corp. 1975 Annual Report. 32 pp.

Mexico.—Mine production of silver in 1975 was 38.0 million ounces. The extensive expansion of mines and plants, and exploration efforts begun in recent years continued in 1975. As a result of these activities Mexico may become the largest silver-producing nation in the world.

Lacana Mining Corp. was formed in September 1975 through the merger of Lacanex Mining Co. Ltd., Pure Silver Mines Ltd., and Tormex Mining Developers Ltd.[15] The new company has a 30% interest in the Las Torres silver-gold mining complex in Guanajuato, and a 40% interest in the La Encantada silver-lead mine in Coahuila in addition to mining operations outside Mexico. Annual silver production at the Las Torres complex was expected to reach 7.2 million ounces, when full production is reached in 1976, from an ore reserve containing 56 million ounces of silver and 434,000 ounces of gold. Silver production at the La Encantada mine in 1975, totaled about 946,000 ounces from a 3.9 million ton ore reserve containing 45.4 million ounces of silver. Expansion work at the La Encantada mine will increase annual production to 3.2 million ounces of silver.

Rosario Mexico, S.A. de C.V., 49%-owned by Rosario Resources Corp., continued its expansion program at the Huautla silver-lead mine in Morelos.[16] Scheduled for completion in late 1976, the new crushing plant will increase the production rate from 140 to 300 tons per day. Silver production in 1975 totaled about 510,000 ounces. At yearend, exploration and development work had increased silver reserves by 10% to 8.2 million ounces.

Explomin, S.A. de C.V., was conducting a feasibility study of the Real de Angeles property in Zacatecas.[17] Diamond drilling of the deposit indicated a reserve of 43 million tons averaging 2.3 ounces of silver per ton, equivalent to 99 million ounces. If put into production, the property could sustain a production rate of about 6 million ounces of silver per year.

Minera Mexicana de Avino, S.A., and Minera San Jose de Avino, S.A., operated its new copper-silver-gold mine north of Durango at near capacity in 1975.[18] The mill has a 500-ton-per-day capacity and processes ore from a 7.3-million-ton reserve containing 20.9 million ounces of silver. Canadian Barranca Corp. conducted exploration programs at the La Gloria mine, Torreon; the A Las Mil Una mine near San Pedro de Gallo; and the Tecolotes mine near San Luis del Cordero.[19] Sampling at the La Gloria mine indicated values of 8 ounces of silver per ton. At the Tecolotes mine, a 30,000-ton dump had an ore grade of 8.62 ounces of silver per ton. Canadian Barranca Corp. also had an interest in the El Palmarito mine, Sinaloa, where exploration and sampling indicated a reserve of 1 million tons containing 5.9 million ounces of silver.

Production of silver at the Real del Monte mine, Hildago, was 3.5 million ounces in 1975, well above the level of 1974. Reserves were estimated at about 25 million ounces. The Lampasos mine in Sonora began operation in April 1975 and production is expected to reach 1 million ounces by 1976.

Nicaragua.—Rosario Mining of Nicaragua, Inc., a subsidiary of Rosario Resources Corp., recorded silver production at the Rosita mine of 383,667 ounces in 1975.[20] The company continued to explore the area around the mine with encouraging results and in the Coco River area where diamond drilling outlined a large low-grade deposit of gold and silver.

Peru.—Mine production of silver in 1975 was 37.8 million ounces compared with 40.2 million ounces in 1974. Development of the Cuajone copper project continued and the property was expected to be in production in 1976. In addition to primary copper, large quantities of byproduct silver will be produced.

Philippines.—Johnson Matthey Chemicals Ltd. received financial backing for its planned gold and silver refinery at Quezon City.[21] The refinery will have an annual capacity of 450,000 ounces of silver and 600,000 ounces of gold.

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[15] Lacana Mining Corporation. 1975 Annual Report. 23 pp.
[16] Page 8 of reference cited in footnote 14.
[17] Northern Miner. Placer Project in Mexico Reaches Feasibility State. V. 61, No. 27, September 1975, p. 49.
[18] Page 49 of reference cited in footnote 17.
[19] Page 54 of reference cited in footnote 17.
[20] Pages 10 and 13 of reference cited in footnote 14.
[21] Chemistry and Industry. Philippines Gold and Silver Refinery. No. 8, Apr. 19, 1975, p 320.

TECHNOLOGY

The Bureau of Mines continued its studies to develop economic methods for recovering silver and associated metals from low-grade or refractory ores. Much of the research dealt with heap leaching, activated carbon gold-silver recovery methods, and elevated-temperature pressurized stripping of gold and silver loaded carbon. The carbon-in-pulp precious metal recovery process was successfully applied, on a pilot scale, to recover about 93% of the silver in 2-ounce-per-ton ore. Recovery rate in other tests exceeded 99%.

Research on gold-silver bearing siliceous fluxing ore, formerly used in copper refining in Montana, indicated that heap leaching followed by flotation of the residue recovered 89.7% of the gold and 84% of the silver, thereby offering the promise of continued operation for producers of the fluxing material. An improved stripping technique was developed for desorption of gold and silver from activated carbon. The process uses alkaline alcohol instead of hot caustic cyanide, and both the rate and extent of stripping were improved.

A promising technique was developed that extracted 91% of the total silver from calcines of a complex refractory oxide silver ore. Minus 100-mesh ground ore mixed with 5% NaCl was pelletized to form 10-mesh X 35-mesh furnace feed which was calcined at 600° C. Cyanidation of the calcine extracted 91% of the total silver.

In other research related to silver, gold telluride flotation concentrates were successfully treated by roasting with lime which allowed the gold to be removed by subsequent cyanidation without the emission of sulfur and tellurium oxides to the atmosphere. Bureau of Mines researchers conducted studies on electronic scrap processing with emphasis on mechanical beneficiation techniques to produce high-grade concentrated fractions of silver, gold, and other metals. It was found that silver could be recovered from stainless steel honeycomb aircraft scrap by shredding and electrolytic stripping.

The high price of silver and other precious metals has caused suppliers of electroplating solutions to produce solutions containing less precious metals and to replace pure precious metals with less expensive alloys.[22] Two new advances using silver were made in solar energy applications.[23] Silver-backed mirrors were developed that reflect 90% of solar light rays making possible the development of more than 17 watts of energy per square foot of mirror. In the other development, silver was used to coat the inside of a glass container which created a green house effect when light rays hit the inside surface and were reflected as long wavelength heat rays that remained within the container. Silver was used to purify water by killing bacteria which cause internal and external infections.[24]

A method was developed for refining silver matte to increase its silver, gold, and platinum-group metal content by reducing its copper, selenium, and tellurium content.[25] The process uses oxygen or oxygen-enriched air to volatilize selenium and tellurium from the molten matte and borax-silica flux to lower the copper content.

[22] Chemical Week. Keeping Precious Metals on the Track. V. 116, No. 17, Apr. 23, 1975, pp. 23–24.

[23] The Mining Record. Two New Developments Use Silver in Solar Energy. V. 86, No. 22, May 28, 1975, p. 1.

[24] The Silver Institute Letter. Russians Focus on Silver for Pure Water. V. 5, No. 9, October 1975, 4 pp.

[25] Sanmiya, T. S., D. G. Kerfoot, and R. R. Matthews (assigned to International Nickel Co., Inc., New York, N.Y.). Refining Silver Bearing Residues. U.S. Pat. 3,902,890, Sept. 2, 1975.

Table 2.—Mine production of recoverable silver in the United States, by month
(Thousand troy ounces)

Month	1974	1975
January	2,654	3,048
February	2,921	2,708
March	3,163	2,920
April	3,097	3,013
May	3,123	2,904
June	3,074	2,993
July	2,489	2,805
August	2,101	2,842
September	2,718	2,867
October	2,878	3,016
November	2,753	2,743
December	2,789	3,079
Total	[1]33,762	34,938

[1] Data do not add to total shown because of independent rounding.

Table 3.—Twenty-five leading silver-producing mines in the United States in 1975, in order of output

Rank	Mine	County and State	Operator	Source of silver
1	Sunshine	Shoshone, Idaho	Sunshine Mining Co	Silver ore.
2	Galena	do	ASARCO Incorporated	Do.
3	Lucky Friday	do	Hecla Mining Co	Lead ore.
4	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Copper ore.
5	Utah Copper	Salt Lake, Utah	Kennecott Copper Corp	Do.
6	Bulldog Mountain	Mineral, Colo	Homestake Mining Co	Silver ore.
7	Sierrita	Pima, Ariz	Duval Sierrita Corp	Copper ore.
8	Bunker Hill	Shoshone, Idaho	The Bunker Hill Co	Lead-zinc ore.
9	Buick	Iron, Mo	Amax Lead Co. of Missouri	Do.
10	Pima	Pima, Ariz	Cyprus Pima Mining Co	Copper ore.
11	Crescent	Shoshone, Idaho	The Bunker Hill Co	Silver ore.
12	Pan American	Lincoln, Nev	St. Patrick Mining Co., Inc	Lead-zinc ore.
13	Star Unit	Shoshone, Idaho	The Bunker Hill Co. and Hecla Mining Co.	Do.
14	White Pine	Ontonagon, Mich	White Pine Copper Co	Copper ore.
15	Magma	Pinal, Ariz	Magma Copper Co	Do.
16	Copper Canyon	Lander, Nev	Duval Corp	Do.
17	Idarado	Ouray and San Miguel, Colo.	Idarado Mining Co	Copper-lead zinc ore.
18	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper, gold-silver ores.
19	Tyrone	Grant, N. Mex	do	Copper ore.
20	San Manuel	Pinal, Ariz	Magma Copper Co	Do.
21	Magmont	Iron, Mo	Cominco American, Inc	Lead ore.
22	Burgin	Utah, Utah	Kennecott Copper Corp	Lead, lead-zinc ores.
23	Ontario	Summit, Utah	Park City Ventures	Lead-zinc ore.
24	Leadville Unit	Lake, Colo	ASARCO Incorporated	Lead-zinc ore, lead-zinc cleanup.
25	Trixie	Utah, Utah	Kennecott Copper Corp	Gold-silver ore.

Table 4.—Production of silver in the United States in 1975, by State, type of mine, and class of ore, yielding silver, in terms of recoverable metal

State	Placer (troy ounces of silver)	Lode: Gold ore: Short tons	Lode: Gold ore: Troy ounces of silver	Lode: Gold-silver ore: Short tons	Lode: Gold-silver ore: Troy ounces of silver	Lode: Silver ore: Short tons	Lode: Silver ore: Troy ounces of silver
Arizona	--	W	W	21,658	1,066	10,118	640
Colorado	--	62,854	774	--	--	179,020	1,726,402
Idaho	--	2,566	1,740	W	W	520,230	9,324,787
Michigan	--	--	--	--	--	--	--
Missouri	--	--	--	--	--	--	--
Montana	W	526	917	21,448	97,911	71,633	357,576
Nevada	--	297,775	9,401	50,478	215,779	991	13,147
New Mexico	--	W	W	4,982	19,642	--	--
New York	--	--	--	--	--	--	--
South Dakota	--	1,473,382	67,669	--	--	--	--
Other States[1]	1,216	414,153	184,382	38,444	341,449	47	709
Total	1,216	2,251,256	264,883	137,010	675,847	782,039	11,423,261
Percent of total silver	([2])	--	1	--	2	--	33

State	Lode—Continued: Copper ore: Short tons	Copper ore: Troy ounces of silver	Lead ore: Short tons	Lead ore: Troy ounces of silver	Zinc ore: Short tons	Zinc ore: Troy ounces of silver
Arizona	151,276,119	6,155,669	W	W	--	--
Colorado	W	W	900	1,915	W	W
Idaho	122,732	37,377	188,319	2,544,979	W	W
Michigan	9,033,308	632,336	--	--	--	--
Missouri	--	--	8,467,794	2,525,042	--	--
Montana	19,261,701	2,151,969	209	3,397	--	--
Nevada	6,822,922	701,940	W	W	800	3,726
New Mexico	19,401,491	660,505	--	--	W	W
New York	--	--	--	--	1,130,439	56,047
South Dakota	--	--	--	--	--	--
Other States[1]	27,416,782	1,740,652	1,774	5,838	2,068,684	307,556
Total	233,335,055	12,080,448	8,658,996	5,081,171	3,199,923	367,329
Percent of total silver	--	35	--	15	--	1

State	Lode—Continued: Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores: Short tons	Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores: Troy ounces of silver	Old tailings, etc.: Short tons	Old tailings, etc.: Troy ounces of silver	Total[3]: Short tons	Total[3]: Troy ounces of silver
Arizona	97,203	41,722	65,773	25,477	151,779,891	6,285,854
Colorado	973,711	1,432,599	2,490	5,435	1,400,159	3,366,000
Idaho	1,073,643	1,948,903	--	--	1,935,363	13,868,133
Michigan	--	--	--	--	9,003,308	632,336
Missouri	--	--	--	--	8,467,794	2,525,042
Montana	W	W	605	1,913	19,356,203	2,616,626
Nevada	403,170	662,496	W	W	7,576,398	1,608,735
New Mexico	--	--	--	--	19,553,193	792,050
New York	--	--	--	--	1,130,439	56,047
South Dakota	--	--	--	--	1,473,382	67,669
Other States[1]	2,442,425	884,308	13	[4]40,574	31,717,182	3,119,090
Total	4,990,152	4,970,028	68,881	73,399	253,423,312	34,937,582
Percent of total silver	--	14	--	([2])	--	100

W Withheld to avoid disclosing individual company confidential data; included in "Other States."
[1] Includes Alaska, California, Illinois, Maine, Oklahoma, Oregon, Tennessee, Utah, Virginia, Washington, Wisconsin, and States indicated by symbol W.
[2] Less than ½ unit.
[3] Data may not add to State totals due to items withheld to avoid disclosing individual company confidential data.
[4] Includes byproduct silver recovered from tungsten ore in California and fluorspar in Illinois.

Table 5.—Mine production of recoverable silver in the United States, by State
(Troy ounces)

	1971	1972	1973	1974	1975
Alaska	868	288	828	547	W
Arizona	6,169,623	6,652,800	7,199,251	6,355,528	6,285,854
California	443,761	175,467	55,897	41,894	79,757
Colorado	3,389,748	3,663,832	3,598,209	2,783,978	3,366,000
Idaho	19,139,575	14,250,725	13,619,824	12,435,701	13,868,133
Maine	41,193	16,251	W	W	W
Michigan	670,052	785,100	850,273	642,944	632,336
Missouri	1,660,879	1,971,530	2,057,732	2,387,250	2,525,042
Montana	2,747,557	3,325,052	4,349,869	3,512,161	2,616,626
Nevada	601,470	595,351	623,660	872,243	1,608,735
New Mexico	782,441	1,016,880	1,111,269	1,194,800	792,050
New York	17,928	25,070	54,345	64,463	56,047
Oregon	3,790	2,252	1,282	8,925	W
South Dakota	106,785	99,992	71,939	62,474	67,669
Tennessee	131,349	83,466	73,104	20,053	53,752
Utah	5,294,477	4,299,604	3,619,038	3,207,923	2,821,730
Other States	362,646	269,262	197,050	170,990	163,851
Total	41,564,142	37,232,922	37,483,570	33,761,874	34,937,582

W Withheld to avoid disclosing individual company confidential data; included in "Other States."

Table 6.—Silver produced in the United States from ore, old tailings, etc., in 1975, by State and method of recovery, in terms of recoverable metal

State	Total ore, old tailings, etc., treated [1] [2] (thousand short tons)	Ore and old tailings to mills					Crude ore, old tailings, etc., to smelters [1]	
		Thousand short tons [1] [2]	Recoverable in bullion		Concentrates smelted and recoverable metal			
			Amalgamation (troy ounces)	Cyanidation (troy ounces)	Concentrates (short tons)	Troy ounces	Thousand short tons	Troy ounces
Arizona	[3] 169,245	[3] 168,788	--	60,346	2,747,026	6,063,510	457	161,998
California	29	28	248	8	2,858	73,780	1	5,570
Colorado	[3] 1,400	[3] 1,396	1,967	16,429	154,207	3,310,673	4	36,931
Idaho	1,936	1,933	--	--	164,303	13,856,915	3	11,218
Michigan	9,033	9,033	--	--	249,242	632,336	--	--
Missouri	8,468	8,468	--	--	904,245	2,525,042	--	--
Montana	19,380	19,262	--	--	297,177	2,158,827	118	457,780
Nevada	[3] [4] 21,712	[3] [4] 21,661	65	218,432	374,414	1,380,914	51	9,324
New Mexico	[3] 19,586	[3] 19,513	--	2,328	661,104	769,969	73	19,753
New York	1,247	1,247	--	--	144,671	56,047	--	--
South Dakota	1,473	1,473	--	67,669	--	--	--	--
Tennessee	4,741	4,741	--	--	217,053	53,752	--	--
Utah	27,752	27,609	--	--	637,750	2,500,024	143	321,706
Other States [5]	1,658	1,652	13	54,865	108,277	104,878	6	3,049
Total	287,660	286,804	2,293	420,077	6,662,327	33,486,667	856	1,027,329

[1] Includes some nonsilver-bearing ore not separable.
[2] Excludes tonnages of fluorspar, tungsten, and uranium ores from which silver was recovered as a byproduct.
[3] Includes ore from which silver was recovered by heap leaching.
[4] Includes ore from which silver was recovered by vat leaching.
[5] Includes Illinois, Maine, Oklahoma, Oregon, Virginia, Washington, and Wisconsin.

Table 7.—Silver produced at amalgamation and cyanidation mills in the United States and percentage of silver recoverable from all sources

Year	Bullion and precipitates recoverable (troy ounces)		Silver recoverable from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [1]	Placers
1971	993	106,785	(2)	0.26	99.74	(2)
1972	2,490	99,992	0.01	.27	99.72	(2)
1973	3,536	260,846	.01	.70	99.29	(2)
1974	2,467	335,909	.01	.99	99.00	(2)
1975	2,293	420,077	.01	1.20	98.79	(2)

[1] Crude ores and concentrates.
[2] Less than ½ unit.

Table 8.—Silver produced at refineries in the United States, by source
(Thousand troy ounces)

Source	1974	1975
Concentrates and ores:		
Domestic	32,368	33,073
Foreign	30,970	27,004
Total [1]	63,338	60,078
Coins	15,900	7,004
Other	r 40,160	42,571
Total [1]	r 56,059	49,574
Total net production [1]	119,397	109,652
New scrap	r 49,881	50,520
Grand total [1]	169,278	160,172

r Revised.
[1] Data may not add to totals shown because of independent rounding.

Table 9.—U.S. consumption of silver, by end use
(Thousand troy ounces)

Final Use [1]	1974	1975
Electroplated ware	13,177	8,717
Sterling ware	22,147	28,717
Jewelry	r 5,102	12,734
Photographic materials	49,579	46,074
Dental and medical supplies	2,401	1,503
Mirrors	3,947	3,150
Brazing alloys and solders	14,514	13,582
Electrical and electronic products:		
Batteries	4,195	4,253
Contacts and conductors	r 31,305	27,211
Bearings	416	458
Catalysts	7,293	8,785
Coins, medallions, commemorative objects	r 21,432	7,186
Miscellaneous [2]	519	281
Total net industrial consumption	r 176,027	[3] 157,650
Coinage	1,017	2,740
Total consumption	r 177,044	[3] 160,390

r Revised.
[1] End use as reported by converters of refined silver.
[2] Includes silver-bearing copper, silver-bearing lead anodes, ceramics, paints, etc.
[3] Data do not add to total shown because of independent rounding.

Table 10.—Value of silver exported from and imported into the United States
(Thousand dollars)

Year	Exports	Imports
1973	27,638	330,456
1974	81,651	623,794
1975	147,567	394,536

Table 11.—U.S. exports of silver in 1975, by country
(Thousand troy ounces and thousand dollars)

Country	Ore and concentrates		Waste and sweepings		Refined bullion	
	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	--	--	--	--	71	328
Australia	--	--	1	1	--	--
Belgium-Luxembourg	8	38	1,703	7,470	(1)	2
Brazil	--	--	17	56	612	2,977
Canada	41	85	2,669	11,976	661	2,792
France	--	--	10	45	--	--
Germany, West	5	19	381	1,479	2,805	12,542
Italy	--	--	--	--	2	6
Japan	--	--	1,690	7,324	1,254	5,979
Korea, Republic of	--	--	5	18	--	--
Mexico	--	--	(1)	1	--	--
Spain	--	--	--	--	64	292
Sweden	--	--	149	481	--	--
Switzerland	9	50	1,159	5,549	5	25
United Kingdom	--	--	2,158	8,889	17,147	79,142
Venezuela	--	--	--	--	(1)	1
Total	63	192	9,942	43,289	22,621	104,086

[1] Less than ½ unit.

Table 12.—U.S. general imports of silver in 1975, by country
(Thousand troy ounces and thousand dollars)

Country	Ore and concentrates		Waste and sweepings		Dore and precipitates		Refined bullion	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	--	--	--	--	--	--	48	222
Australia	2,044	8,976	(1)	1	--	--	96	419
Belgium-Luxembourg	--	--	--	--	--	--	29	122
Bolivia	101	514	--	--	--	--	--	--
Brazil	--	--	41	177	--	--	8	45
Canada	7,805	34,268	4,600	19,332	416	1,946	21,500	94,720
Chile	84	399	--	--	209	941	286	1,486
Colombia	18	77	--	--	--	--	--	--
Denmark	107	428	--	--	--	--	--	--
France	--	--	--	--	(1)	1	--	--
Germany, West	--	--	232	1,404	(1)	1	--	--
Greece	--	--	8	1	--	--	--	--
Honduras	2,658	7,855	--	--	127	558	--	--
Hong Kong	--	--	4	13	--	--	--	--
Italy	--	--	3	13	--	--	2	10
India	--	--	--	--	--	--	66	330
Jamaica	--	--	3	3	--	--	--	--
Japan	--	--	175	649	563	2,430	5,056	22,778
Korea, Republic of	--	--	--	--	--	--	65	307
Mexico	1,602	7,046	285	1,282	80	343	19,444	87,605
Netherlands	--	--	7	28	--	--	1	5
Nicaragua	61	261	--	--	15	66	--	--
Norway	34	109	--	--	--	--	--	--
Panama	--	--	8	47	--	--	1	2
Peru	5,838	22,049	--	--	766	3,054	11,596	50,813
Philippines	180	792	18	75	--	--	--	--
Poland	--	--	--	--	--	--	101	472
Singapore	--	--	2	8	--	--	--	--
South Africa, Republic of	196	769	--	--	--	--	--	--
South West Africa	971	4,196	--	--	--	--	--	--
Spain	--	--	(1)	1	--	--	--	--
Switzerland	--	--	--	--	10	43	29	159
Taiwan	--	--	1	3	--	--	--	--
United Kingdom	3	14	13	58	2	8	5	16
Venezuela	--	--	8	41	--	--	--	--
Yemen (Aden)	(1)	2	--	--	--	--	--	--
Yugoslavia	--	--	--	--	--	--	3,296	14,743
Total	21,197	87,755	5,408	23,136	2,188	9,391	61,629	274,254

[1] Less than ½ unit.

Table 13.—Silver: World production[1] by country
(Thousand troy ounces)

Country[2]	1973	1974	1975 p
North and Central America:			
Canada	47,488	42,810	39,101
Costa Rica	(3)	3	e 3
Dominican Republic	--	--	109
El Salvador	123	168	e 150
Guatemala e	10	10	10
Haiti e	17	20	20
Honduras	3,152	3,661	3,802
Mexico	38,788	37,546	38,029
Nicaragua	180	270	324
United States	r 37,827	33,762	34,938
South America:			
Argentina	2,441	2,000	e 2,000
Bolivia[4]	5,803	5,385	5,464
Brazil[5]	322	251	e 250
Chile	5,035	6,646	6,263
Colombia[5]	r 7	80	88
Ecuador	57	35	e 40
Peru	42,021	40,249	37,783
Europe:			
Austria[5]	192	--	--
Bulgaria e	800	800	800
Czechoslovakia e	1,100	1,100	1,100
Finland[5]	793	810	744
France	r 1,656	1,521	e 1,500
Germany, East e	4,000	3,000	2,000
Germany, West	1,446	1,235	e 1,200
Greece[5]	588	575	480
Greenland e	120	390	380
Hungary	7	7	7
Ireland	1,839	1,980	1,384
Italy[5]	1,349	1,303	e 1,200
Poland e	4,800	6,000	6,500
Portugal	r 126	24	23
Romania e	1,100	1,100	1,100
Spain[5]	r 4,157	4,099	[5] 3,525
Sweden	r 4,739	4,545	e 4,300
U.S.S.R. e 5	41,000	42,000	43,000
Yugoslavia	4,302	4,702	5,412
Africa:			
Algeria e	170	r 140	200
Kenya	(3)	20	e 20
Morocco	r 3,382	3,064	e 3,560
Rhodesia, Southern[6]	169	156	e 150
South Africa, Republic of	3,652	2,699	3,084
South West Africa, Territory of[7]	1,563	[8] 1,556	1,500
Tanzania	(3)	(3)	(3)
Tunisia	190	136	e 130
Zaire	1,995	1,649	2,291
Zambia[9]	78	287	193
Asia:			
Burma	754	722	775
China, People's Republic of	800	800	800
India	r 137	147	e 135
Indonesia	r 819	1,074	e 1,000
Japan	r 8,554	7,314	8,649
Korea, North e	700	700	700
Korea, Republic of	1,490	1,291	1,504
Philippines	r 1,891	1,706	1,620
Taiwan	93	33	6
Oceania:			
Australia	22,423	21,697	23,537
Fiji	30	27	26
New Zealand	49	2	e 2
Papua and New Guinea	1,581	1,628	1,357
Total	r 307,974	294,935	294,268

e Estimate. p Preliminary. r Revised.
[1] Recoverable content of ores and concentrates produced unless otherwise noted.
[2] In addition to the countries listed, Ghana, Mauritania, Thailand, and Turkey produce silver, but information is inadequate to make reliable estimates of output levels.
[3] Less than ½ unit.
[4] Includes production by the State mining company (COMIBOL) plus the exports of medium and small (private sector) mines.
[5] Smelter and/or refinery production.
[6] Output of Inyati mine only.
[7] Data represent recoverable content of Tsumeb Corp. Ltd. concentrates as well recovery from copper refinery sludges.
[8] Includes estimate for Klein Aub Koper Maatskappy Ltd.
[9] Includes recovery from copper refinery sludges.

Slag — Iron and Steel

By Walter Pajalich [1]

Combined output of both types of slag declined 15% in quantity and 7% in value below 1974 levels. Production of iron slag declined 15% in quantity and 7% in value, whereas that of steel slag decreased 18% in quantity and 20% in value. The tonnage of screened, air-cooled iron slag declined 15%, whereas the tonnage of granulated and expanded iron slag declined 16%.

The price per ton of iron slag increased 10% and steel slag decreased 3%. Despite a price increase, iron slag continued to be strongly competitive with similar construction materials.

A sharp gain in exports was recorded; volume rose 169% and value more than doubled. No imports of slag were reported in 1975.

Table 1.—Iron-blast-furnace slags processed in the United States, by type
(Thousand short tons and thousand dollars)

Year	Air-cooled				Granulated		Expanded		Total	
	Screened		Unscreened							
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1973	23,692	50,737	1,279	1,512	1,999	3,667	1,852	6,936	28,822	62,852
1974	25,557	56,431	669	796	2,081	4,442	1,573	6,461	29,880	68,130
1975	21,616	52,442	626	944	1,780	4,335	1,302	5,934	25,324	63,655

Source: National Slag Association.

DOMESTIC PRODUCTION

The volume of iron slag processed in 1975 was 25.3 million tons valued at $63.7 million, compared with 29.9 million tons valued at $68.1 million in 1974. Production of the principal type of iron slag—screened, air-cooled slag—totaled 21.6 million tons valued at $52.4 million, representing declines of 15% and 7%, respectively, from the production and value levels of 1974. Output of unscreened, air-cooled material declined slightly. Of the 12% of iron slag processed using water techniques, granulated slags declined to 1.8 million tons valued at $4.3 million, whereas expanded slags declined to 1.3 million tons valued at $5.9 million. Steel slag declined 18% to 7.3 million tons and the value declined 20% to $9.0 million.

A total of 50 companies operated 74 air-cooling, 7 expanding, and 10 granulating slag plants. Slag-encrusted iron reclaimed magnetically by slag processors for resmelting totaled 2,667,929 tons. The 1,843 plant and yard employees in the industry worked 2,486,397 man-hours.

About 22% of all slag was produced in Pennsylvania, 21% in Ohio, and 24% in Illinois, Indiana, and Michigan. The remaining 33% came from Alabama, California, Colorado, Kentucky, Maryland, New York, Texas, Utah, and West Virginia.

[1] Mining engineer, Division of Nonmetallic Minerals.

Table 2.—Iron-blast-furnace slags processed in the United States, by State
(Thousand short tons and thousand dollars)

Year and State	Screened and air-cooled		All types	
	Quantity	Value	Quantity	Value
1974				
Ohio	5,038	12,515	6,109	15,646
Pennsylvania	5,168	12,960	6,712	16,101
Illinois, Indiana, Michigan	5,916	11,841	6,705	15,159
Other States[1]	9,435	19,115	10,354	21,224
Total	25,557	56,431	29,880	68,130
1975				
Ohio	4,083	10,487	5,364	13,348
Pennsylvania	4,281	11,042	6,184	17,399
Illinois, Indiana, Michigan	6,046	14,464	5,540	13,638
Other States[1]	7,206	16,449	8,236	19,270
Total	21,616	52,442	25,324	63,655

[1] Includes Alabama, California, Colorado, Kentucky, Maryland, New York, Texas, Utah, and West Virginia.

Source: National Slag Association.

CONSUMPTION AND USES

As in past years, nearly all of the slag produced in the manufacture of pig iron and steel was either recycled or used by the construction industry.

A 15% decrease in overall consumption of screened, air-cooled iron slag was accounted for principally by a 5% decrease in shipments for highway and airport construction, a 44% decrease in use for portland-cement concrete construction, and a 31% decrease in bituminous construction use. Together, these uses accounted for 72% of the total consumption of this type of iron slag. Most recorded uses declined for the year. Consumption of unscreened, air-cooled iron slag declined 6%. The principal use, highway and airport construction, recorded an 8% decline, and numerous minor applications nearly disappeared.

The volume of granulated iron slag consumed declined 14% and that of expanded iron slag declined 17%. In its principal use, highway construction, granulated slag was down 30%. Some uses for granulated slag recorded gains. In the principal use for expanded slag, concrete block manufacture, consumption was down 17%. All other significant uses of expanded slag recorded declines. No expanded iron slag was reported for use in manufacture of cement.

Consumption of steel slag was 18% below that of 1974, and was characterized by fluctuations throughout its range of uses. Use as paved-area base, miscellaneous base, and bituminous mixes was 33% less in 1975. There was a significant increase in use as highway base. No steel slag was used in agriculture in 1975.

Laboratory research programs indicated that a satisfactory base stabilization process has been developed using ground pelletized blast furnace slag (30%) and air-cooled blast furnace slag (70%) with suitable mixture of water. Pelletizing involves expanding the molten blast furnace slag under water sprays on a feed plate and passing this pyroplastic material over a pelletizing drum to form glassy pellets with cementitious properties. The cementitious nature of such ground pelletized slag makes it a viable alternative to the use of asphalt and portland cements for base stabilization applications and brick manufacture, with a considerable saving of energy.[2]

[2] Emery, J. J., R. P. Cottsworth, and C. S. Kim. Ground Pelletized Slag Base Stabilization. Prepared for the International Conference on Slags, Scorias and Waste Products, Mons, Belgium, Sept. 10–12, 1975, 18 pp.

Table 3.—Shipments of iron slag in the United States, by method of transportation

Method of transportation	1974 Thousand short tons	1974 Percent of total	1975 Thousand short tons	1975 Percent of total
Rail	6,845	23	6,129	24
Truck	21,891	73	18,142	72
Waterway	1,144	4	1,053	4
Total	29,880	100	25,324	100

Source: National Slag Association.

Table 4.—Air-cooled iron slag sold or used by processors in the United States, by use
(Thousand short tons and thousand dollars)

Use	1974				1975			
	Screened		Unscreened		Screened		Unscreened	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Aggregate in—								
Portland cement concrete construction	2,887	7,200	--	--	1,620	4,572	--	--
Bituminous construction (all types)	4,943	11,378	--	--	3,396	8,911	--	--
Highway and airport construction [1]	11,025	23,802	589	725	10,504	25,516	539	847
Manufacture of concrete block	433	1,116	--	--	343	1,007	--	--
Railroad ballast	4,027	6,861	--	--	4,029	7,490	6	13
Mineral wool	585	1,457	--	--	589	1,848	--	--
Roofing slag:								
Cover material	269	947	--	--	232	1,072	--	--
Granules	3	15	--	--	6	21	--	--
Sewage trickling filter medium	28	55	--	--	29	47	--	--
Agricultural slag, liming	1	2	--	--	2	3	--	--
Other uses	1,356	3,598	80	71	866	1,955	81	84
Total	25,557	56,431	669	796	21,616	52,442	626	944

[1] Other than in portland cement concrete and bituminous construction.

Source: National Slag Association.

Table 5.—Granulated and expanded iron slags sold or used by processors in the United States, by use
(Thousand short tons and thousand dollars)

Use	1974				1975			
	Granulated		Expanded		Granulated		Expanded	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Highway construction and fill (road, etc.)	1,376	2,264	--	--	959	2,032	--	--
Agricultural slag, liming	50	123	--	--	52	129	--	--
Manufacture of cement (all types)	313	[e] 1,332	179	[e] 626	[1] 228	1,201	--	--
Lightweight concrete	--	--	19	66	--	--	162	841
Aggregate for concrete-block manufacture	136	418	1,316	5,616	230	429	1,092	4,976
Other uses	206	305	59	153	311	544	48	117
Total	2,081	4,442	1,573	6,461	1,780	4,335	1,302	5,934

[e] Estimate.
[1] In addition, air-cooled slag was used in the manufacture of portland cement—258,000 tons in 1974 and 47,400 tons in 1975.

Source: National Slag Association.

Table 6.—Steel slag sold or used by processors in the United States, by use[1]
(Thousand short tons and thousand dollars)

Use	1974 Quantity	1974 Value	1975 Quantity	1975 Value
Railroad ballast	689	943	613	745
Highway base or shoulders	1,888	2,445	2,701	3,239
Paved-area base	2,190	2,516	1,514	2,201
Miscellaneous base or fill	2,893	3,027	1,947	2,233
Bituminous mixes	501	752	280	313
Agricultural	157	707	--	--
Other uses	544	805	247	234
Total	8,862	11,195	7,302	8,965

[1] Excludes tonnage returned to furnace for charge material.

Source: National Slag Association.

PRICES

Slag producers reported generally rising prices in 1975 in nearly all slag applications. The overall average f.o.b. plant price for iron slag rose from $2.28 per ton in 1974 to $2.51 per ton in 1975. The price of steel slag dropped slightly from $1.26 per ton to $1.23 per ton.

The average price of screened, air-cooled iron slag in 1975 was $2.43 per ton compared with $2.21 per ton in 1974. For aggregate use, the average price rose 11% to $2.52 per ton; for railroad ballast, 9% to $1.86 per ton; and mineral wool, 26% to $3.14 per ton. A 28% increase in the price per ton of unscreened slag used for highway construction was recorded in 1975.

The average price of granulated and expanded slags was 15% and 11% higher, respectively, than that of 1974. The price of granulated slag used in highway and airport construction, the principal use, rose 28% to $2.12 per ton; prices for other major uses generally increased. Price increases were recorded for expanded slag in the manufacture of concrete block and lightweight concrete.

Highway, paved-area, and miscellaneous base uses accounted for about 84% of the total use of steel slag. Price decreases for steel slag ranged from $0.10 per ton to $0.53 per ton in 1975. Increases ranged from $0.10 to $0.30 per ton. Steel slag used for railroad ballast decreased $0.15, highway base $0.10, bituminous mixes $0.38, and other uses $0.53 per ton. Material used for paved-area base increased $0.30 per ton and miscellaneous base or fill increased $0.10 per ton.

Table 7.—Average value of iron slags sold or used by processors in the United States, by use
(Per short ton)

Use	Air-cooled				Granulated		Expanded	
	Screened		Unscreened					
	1974	1975	1974	1975	1974	1975	1974	1975
Aggregate in—								
Portland cement concrete construction	$2.49	$2.82	--	--	--	--	--	--
Bituminous construction (all types)	2.30	2.62	--	--	--	--	--	--
Highway and airport construction[1]	2.16	2.43	r $1.23	$1.57	r $1.65	$2.12	--	--
Manufacture of concrete block	r 2.58	2.94	--	--	r 3.07	1.87	r $4.27	$4.56
Lightweight concrete	--	--	--	--	--	--	3.47	5.19
Railroad ballast	r 1.70	1.86	--	2.17	--	--	--	--
Mineral wool	2.49	3.14	--	--	--	--	--	--
Roofing slag:								
Cover material	3.52	4.62	--	--	--	--	--	--
Granules	5.00	3.50	--	--	--	--	--	--
Sewage trickling filter medium	1.96	1.62	--	--	--	--	--	--
Agricultural slag, liming	2.00	1.50	--	--	2.46	2.48	--	--
Other uses	2.65	2.26	r .89	1.04	1.48	1.75	r 2.59	2.44

r Revised.
[1] Other than in portland cement and bituminous construction.

Source: National Slag Association.

FOREIGN TRADE

Exports of iron and steel slag increased sharply to 139,516 tons valued at $5.5 million. Nevertheless, exports were equivalent to only 0.4% of the quantity and 8% of the value of domestic production of slag.

The high unit value for exported slag, $39.46 per ton on the average, was indicative of the high metal content of the material. Increased exports to Canada and Japan accounted for nearly all of the increase in quantity and value of exports. About 88% of the exported material went to these countries; Canada alone accounted for 55%. Other countries receiving significant quantities were Belgium-Luxembourg, Mexico, and Guatemala.

Imports of slag in 1975, if any, were not reported in official statistics.

Table 8.—U.S. exports [1] of slag, dross, and scaling from the manufacture of iron and steel

Country	1974		1975	
	Short tons	Value	Short tons	Value
Argentina	61	$555	--	--
Australia	591	6,267	19	$1,500
Bahamas	150	4,950	--	--
Belgium-Luxembourg	544	177,417	9,422	1,040,199
Bermuda	20	700	--	--
Brazil	--	--	27	29,048
Canada	37,303	1,308,461	76,770	3,031,076
Colombia	14	1,155	1	1,134
Dominican Republic	--	--	11	1,438
Guatemala	273	4,777	1,355	53,672
Italy	20	695	--	--
Japan	1	611	45,793	648,164
Mexico	12,087	835,741	5,746	516,183
Netherlands	88	1,350	5	7,953
Nigeria	40	3,000	--	--
Pakistan	46	51,482	--	--
Panama	--	--	1	1,403
South Vietnam	165	26,758	--	--
Taiwan	--	--	25	2,015
United Kingdom	461	96,787	319	170,345
Venezuela	38	3,069	22	1,760
Total	51,902	2,523,775	139,516	5,505,890

[1] No imports in 1975.

Sodium and Sodium Compounds

By Charles L. Klingman [1]

The year 1975 was not a normal one for the production and consumption of sodium compounds. Smaller demands in nearly all uses restricted production, but at the same time prices were significantly higher. A summary of the quantity and value, based on yearend prices, of natural sodium compounds and metallic sodium produced in 1975 is as follows:

	Production (thousand short tons)	Value (thousand dollars)
Soda ash	4,328	182,620
Sodium sulfate	667	27,667
Metallic sodium	144	e 60,187

e Estimate.

Naturally derived soda ash and sodium sulfate fared better than the synthetic or byproduct varieties. Natural sodium sulfate production dropped only 2% from the 1974 figure, compared with a 16% loss for the byproduct salt cake. Naturally derived soda ash increased 7% in contrast with a 20% decline in Solvay soda ash production. There were two closures of Solvay soda ash plants in 1975, while all producers of natural soda ash were enlarging their plants. Production capacity for natural soda ash was scheduled to rise 54% to about 10 million tons per year by 1980.

Exports of soda ash remained high at 7.8% of production. Importation of sodium sulfate was about 20% of the apparent consumption. Total exports of both salts were higher in value than total imports by $39 million.

DOMESTIC PRODUCTION

Overall soda ash production in 1975 decreased 6%, but the natural product derived from trona or brine showed an increase of 7%. Synthetic or Solvay soda ash continued to decline by dropping 20% below the 1974 production level. In 1975, natural soda ash accounted for 61% and Solvay carbonate fell to 39% of the total. Table 2 shows the trend over the past 10 years from Solvay to natural soda ash.

There were two closings of major Solvay soda ash plants in 1975: Allied Chemical Corp.'s plant at Baton Rouge, La., in May with a nominal capacity for 785,000 tons per year and Olin Corp.'s plant at Lake Charles, La., in September with a nominal capacity for 350,000 tons per year. The four remaining Solvay plants in the United States had a combined nominal capacity for 2.9 million tons per year.

At yearend 1975, four companies operating five plants for production of natural soda ash had a nominal capacity of 6.5 million tons per year, or 69% of the total U.S. soda ash capacity. Announced expansions in plant capacity reportedly will increase the totals by yearend 1976 to 7.5 million tons, and at yearend 1977 to 8.8 million tons per year. Texasgulf, Inc., which is scheduled to open its new million-ton-per-year mine and plant in 1976 (included in the previous figures), had plans for doubling its output when practical after its first unit is operational. Stauffer Chemical Co. also announced its intention to raise capacity another 200,000 tons per year by 1977. This will place the natural soda ash capacity for the United States at about 10.0 million tons per year. Domestic demand for soda ash was not predicted to increase as fast as production capacity, so overcapacity may result, es-

[1] Physical scientist, Division of Nonmetallic Minerals.

pecially if the present Solvay plants remain in operation. Increased exportation of soda ash may relieve an overcapacity situation.

Allied Chemical Corp. had a 6-week strike at its Green River, Wyo. soda ash plant which ended September 12, 1975.

Soda ash stocks on hand increased about 18,000 tons during 1975.

There was a decrease of 9% in total sodium sulfate production, with the manufactured variety showing a 16% drop and the natural product displaying a reduction of only 2%. In 1975, there were three companies operating five plants in California, Texas, and Utah for the production of natural sodium sulfate. The sodium sulfate production of U.S. Borax & Chemical Corp. will be excluded from the total after this year because its sulfate is essentially a byproduct of boric acid manufacture rather than an earth-derived compound. Kerr-McGee Chemical Corp. was in the process of building a new plant at Searles Lake, Calif., which is scheduled to increase its sodium sulfate capacity by 150,000 tons per year by yearend 1977.

Byproduct sodium sulfate was supplied by 18 companies operating 23 plants in 15 States with a nominal production capacity of 754,000 tons per year. About three-fourths of these plants were located east of the Mississippi River.

In the fall of 1975, the Bureau of Mines started publishing monthly Mineral Industry Surveys showing production of naturally derived soda ash and sodium sulfate in the United States. The January 1976 issue contained a 6-year monthly historical tabulation of this production.

Production of metallic sodium fell 17% to 143,989 tons in 1975. Table 4 shows the trend in production and in the price of metallic sodium for the past 10 years.

Table 1.—Manufactured and natural sodium carbonates produced in the United States
(Thousand short tons and thousand dollars)

Year	Manufactured soda ash (ammonia-soda process)[1] [2]	Natural sodium carbonates[3]		Total Quantity
	Quantity	Quantity	Value	
1971	4,298	2,865	60,774	7,163
1972	4,305	3,218	71,689	7,523
1973	3,813	3,722	94,385	7,535
1974	3,507	4,059	137,486	7,566
1975	2,802	4,328	182,620	7,130

[1] Current Industrial Reports, Inorganic Chemicals, U.S. Department of Commerce, Bureau of the Census.
[2] Includes quantities used to manufacture caustic soda, sodium bicarbonate, and finished light and dense soda ash.
[3] Soda ash and trona (sesquicarbonate).

Table 2.—Source of U.S. soda ash by process, 1966–75
(Thousand short tons)

Year	Solvay		Natural	
	Production	Percent total	Production	Percent total
1966	5,071	74.5	1,738	25.5
1967	4,849	73.7	1,726	26.3
1968	4,596	69.2	2,043	30.8
1969	4,540	64.5	2,495	35.5
1970	4,393	62.1	2,678	37.9
1971	4,298	60.0	2,865	40.0
1972	4,305	57.2	3,218	42.8
1973	3,813	50.6	3,722	49.4
1974	3,507	46.4	4,059	53.6
1975	2,802	39.3	4,328	60.7

Table 3.—Sodium sulfate produced and sold or used by producers in the United States [1]
(Thousand short tons and thousand dollars)

Year	Production (manufactured and natural) [2]			Sold or used by producers (natural only)	
	Lower purity [3] (99% or less)	High purity	Total quantity [4]	Quantity	Value
1971	514	843	1,357	688	11,008
1972	526	801	1,327	701	11,396
1973	r 530	r 907	r 1,438	672	11,597
1974	r 565	r 783	r 1,348	684	16,411
1975	431	796	1,227	667	27,667

r Revised.
[1] All quantities converted to 100% Na_2SO_4 basis.
[2] Bureau of the Census. Current Industrial Reports, Inorganic Chemicals.
[3] Includes Glauber's salt.
[4] Data may not add to totals shown because of independent rounding.

Table 4.—Production and price of metallic sodium in the United States

Year	Production (short tons)	Price (cents per pound)
1966	164,884	15.35
1967	164,528	15.36
1968	156,391	15.47
1969	164,685	15.84
1970	171,251	15.94
1971	153,075	16.26
1972	160,504	16.98
1973	176,903	17.43
1974	173,174	17.89
1975	143,989	e 20.90

e Estimate.

A list of U.S. producers of natural sodium compounds and metallic sodium follows:

Product and company	Plant location	State	Source of sodium
Soda ash:			
Kerr-MeGee Chemical Corp	Trona	California	Dry lake brine.
Do	Westend	do	Do.
Allied Chemical Corp	Green River	Wyoming	Underground trona.
FMC Corp	do	do	Do.
Stauffer Chemical Co	do	do	Do.
Sodium sulfate:			
Kerr-McGee Chemical Corp	Trona	California	Dry lake brine.
Do	Westend	do	Do.
U.S. Borax & Chemical Corp	Boron	do	Open pit mining.
Ozark-Mahoning Co	Brownfield	Texas	Subterranean brine.
Do	Seagraves	do	Do.
Great Salt Lake Minerals & Chemicals Corp.	Ogden	Utah	Salt lake brine.
Metallic sodium:			
E. I. du Pont de Nemours & Co	Niagara Falls	New York	Salt.
Do	Memphis	Tennessee	Do.
Ethyl Corp	Baton Rouge	Louisiana	Do.
Do	Houston	Texas	Do.
RMI Co	Ashtabula	Ohio	Do.

CONSUMPTION AND USES

The percent usage of soda ash and sodium sulfate as given in the Chemical Marketing Reporter[2] are quoted below:

Industry	Percent of demand	
	Soda ash	Sodium sulfate
Pulp and paper	7	70
Glass	47	--
Detergents	6	20
Chemicals	25	--
Water treatment	3	--
Other and exports	12	10

The Bureau of Mines does not conduct direct surveys of consumers of sodium compounds, so information on consumption was derived from secondary sources. In 1975, however, some of the sodium-consuming industries were quite depressed and did not utilize as much of the sodium-bearing materials as they did in 1974.

The pulp and paper industry required only 86% of the previous year's soda ash and sodium sulfate requirements. Window glass and glass fibers production was also below 1974 levels. Glass for bottles and other containers, however, held up very well in 1975.

Production of plastics and resin products was down 30% from the 1974 level, and miscellaneous inorganic chemicals were lower by 20% to 25%. Production of soaps and detergents was up an estimated 9% over 1974. The demand for antiknock compounds in gasoline was reduced in 1975 by the mandatory use of catalytic converters on most new automobiles. The consumption of metallic sodium required in the manufacture of antiknock compounds was consequently reduced 17%.

Production of chlorine-caustic soda was of significance because of the interchangeability of soda ash and caustic soda. During 1975, there was a sharp drop in demand for chlorine because of declines in chlorinated solvents, chemicals, and paper products. This reduced the availability of caustic soda, coproduct of chlorine production and allowed soda ash to penetrate caustic soda markets.

PRICES

Prices of natural soda ash and natural sodium sulfate were derived from the Bureau of Mines annual survey. Producers were asked to place a value on their finished products in bulk at the dock without transportation charges. The average prices derived from these surveys follow:

	Value, dollars per short ton		Change, %
	1974	1975	
Bulk soda ash	33.87	42.20	+25
Bulk sodium sulfate	23.99	41.48	+73

A tabulation of prices as quoted in trade journals for various grades and packaging of soda ash, sodium sulfate, and metallic sodium follows:

		1974[1]	1975
Sodium carbonate (soda ash):			
Light, paper bags, carlots, works	per ton	$56.00–74.00	$57.00–71.00
Light, bulk, carlots, works	do	54.00–64.00	57.00–64.00
Dense, paper bags, carlots, works	do	42.00–42.50	57.00–71.00
Dense, bulk, carlots, works	do	42.00–54.00	47.00–49.00
Sodium sulfate (100% Na_2SO_4):			
Technical detergent, rayon-grade, bags, carlots	do	43.00–46.00	60.00–65.00
Technical detergent, rayon-grade, bulk, works	do	33.00–38.00	55.00
Domestic salt cake, bulk, works[2]	do	31.00	60.00
National Formulary (N.F. XII), drums	per pound	.23½	.23½
Metallic sodium:			
Bricks, carlots, works	do	.30	.30
Fused, lots 18,000 pounds and more, works	do	.26½–.27½	.26½–.27½
Bulk, tank, works	do	.18¾	.22½

[1] Chemical Marketing Reporter. Current Prices of Chemicals and Related Materials. V. 208, No. 26, Dec. 29, 1975.
[2] East of Mississippi River.

[2] Chemical Marketing Reporter. Sodium Sulfate. V. 207, No. 8, Feb. 24, 1975, p. 9.
———. Soda Ash. V. 208, No. 8, Aug. 25, 1975, p. 9.

FOREIGN TRADE

In 1975 soda ash exports from the United States amounted to 552,000 tons, which was 7.8% of the total production. Only 3,000 tons of soda ash was imported. Forty-four percent of U.S. exports went to other North American countries, 36% to South America, 14% to Asia and Oceania, 5% to Africa, and 1% to Europe.

The United States imported about 20% of its sodium sulfate demand, two-thirds of which came from Canada and one-third from Belgium-Luxembourg. It exported 6% of its sodium sulfate production, the bulk of which went to Oceania and Asia.

The value of exports of sodium compounds exceeded the value of imports by over $39 million. The Department of Commerce, which obtained original data on soda ash exports under Schedule B, No. 5147005, nominally excluded the naturally derived product. Some exported natural soda ash may, therefore, have been classified in a basket category and thereby be excluded from Federal Bureau of Mines export records.

Table 5.—U.S. exports of sodium carbonate and sodium sulfate
(Thousand short tons and thousand dollars)

Year	Sodium carbonate		Sodium sulfate	
	Quantity	Value	Quantity	Value
1973	425	16,064	45	2,049
1974	564	34,156	51	3,250
1975	552	45,985	77	6,144

Table 6.—U.S. imports for consumption of sodium sulfate
(Thousand short tons and thousand dollars)

Year	Crude (Salt cake) [1]		Anhydrous		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1973	240	4,054	80	1,602	320	5,656
1974	277	7,162	98	3,220	375	10,382
1975	203	8,305	82	4,319	285	12,624

[1] Includes glauber's salt as follows: 1973, 110 tons ($2,200); 1974, 1,270 tons ($29,166); 1975, none.

Table 7.—U.S. imports for consumption of sodium carbonate and bicarbonate in 1975
(Thousand short tons and thousand dollars)

	Quantity	Value
Soda ash	2	341
Sodium bicarbonate	1	79
Total	3	420

WORLD REVIEW

Tables 8 and 9 show world production of soda ash and sodium sulfate by countries. From these tables it can be seen that the United States produced 98% of the world's natural soda ash, and the United States and Canada together produced 56% of the world's natural sodium sulfate. The five top-ranking soda ash producing nations of the world, in order, were: the United States, the U.S.S.R. France, West Germany, and Japan. The five top-ranking nations in the production of sodium sulfate were: the United States, the U.S.S.R., Canada, Mexico, and Japan.

In 1975, the consumption of soda ash in Europe was on the increase primarily because of reduced production of chlorine and its coproduct, caustic soda. There were environmental pressures on the chlorine derivatives in Europe as well as in the United States, and chlorine production was restricted accordingly. Soda ash was the logical replacement for caustic soda in the manufacture of chemicals and alumina.

The Akzo soda ash plant at Delfzijl, Netherlands announced an increase in its soda ash capacity by 30% to be completed by 1977. Solvay & Cie. S.A. was also considering doubling its soda ash production to 800,000 tons per year at Couillet, Belgium.

Table 8.—Sodium carbonate: World production by country

(Thousand short tons)

Country [1]	1973	1974	1975 p
Natural:			
Chad	6	6	6
Kenya [2]	r 227	184	101
United States [3]	3,722	4,059	4,328
Total	r 3,955	4,249	4,435
Manufactured:			
Albania	23	e 23	e 23
Belgium e	430	r 446	450
Brazil e	140	140	140
Bulgaria	278	r e 280	e 280
Chile e	11	11	9
Colombia e	22	22	22
Czechoslovakia	128	170	e 170
Denmark [4]	1	1	1
France	r 1,696	1,725	1,409
Germany, East	860	886	e 890
Germany, West	1,568	1,605	1,377
India	517	562	594
Italy e	r 830	r 794	730
Japan	1,503	1,463	1,238
Korea, Republic of	93	107	140
Mexico	421	444	453
Netherlands	283	326	244
Norway	21	23	e 23
Pakistan	r 85	89	87
Poland	799	804	805
Portugal	128	149	e 150
Romania	746	890	e 895
Spain	487	531	e 531
Sweden	r 1	e 1	e 1
U.S.S.R	r 4,573	4,943	e 5,240
United States	3,813	3,507	2,802
Yugoslavia	142	157	162
Total	r 19,599	20,099	18,866

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, a number of nations are either known or believed to have produced sodium carbonate, but production is unreported, and available general information is inadequate for the formulation of reliable estimates of output levels. Notable among the producing countries not listed are Australia, Canada, the People's Republic of China, and the United Kingdom.

[2] Quantity reported for sodium carbonate in 1972 has been revised by official sources from 164,000 short tons to 181,000 short tons.

[3] Sold or used by producers.

[4] Production for sale only; excludes output consumed by producers.

Table 9.—Sodium sulfate: World production by country
(Thousand short tons)

Country[1]	1973	1974	1975 p
Natural:			
Argentina	48	34	e 34
Canada	543	703	546
Chile[2]	5	10	13
Iran	20	28	28
Mexico	192	163	331
Spain	r 134	142	e 145
Turkey	41	61	88
U.S.S.R.e [3]	290	310	330
United States[4]	672	684	667
Total	r 1,945	2,135	2,182
Manufactured:			
Chile[5]	40	35	25
France	180	183	162
Germany, East	206	216	e 216
Germany, West	322	309	283
Greece	5	r e 6	e 6
Hungary e	11	11	11
Italy	117	r e 117	e 117
Japan	r 456	418	324
Portugal	54	54	e 55
Spain[6]	r 128	130	e 132
U.S.S.R.e [3]	210	220	230
United States[7]	r 766	664	560
Total	r 2,495	2,363	2,121

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed, the People's Republic of China, Poland, Romania, and the United Kingdom are assumed to have produced manufactured sodium sulfate, and other unlisted countries may have produced this commodity, but production figures are not reported and available general information is inadequate for the formulation of reliable estimates of output levels.
[2] Natural mine output, excluding byproduct output from the nitrate industry which is reported under manufactured.
[3] Conjectural estimates based on 1968 information on natural sodium sulfate only.
[4] Sold or used by producers.
[5] Byproduct of nitrate industry.
[6] Quantities of manufactured sodium sulfate credited to Spain are reported in official sources in such a way as to indicate that they are in addition to the quantities reported as mined (reported in this table under natural) but some duplication may exist.
[7] Derived approximate figure; difference between reported total sodium sulfate production (natural and manufactured, undifferentiated) and reported quantity of natural sodium sulfate sold or used by producers.

Argentina.—At the end of 1975, plans were being finalized to build a Solvay plant capable of producing 220,000 tons of soda ash per year near San Antonio Oeste in southern Argentina. This will be Argentina's first soda ash facility and will be a joint effort between the Argentine firm of Alcalis de la Patagonia and PPG Industries Inc. of the United States. The building contractor is Ferrostaal, A.G. of West Germany. The proposed plant is adjacent to one of the world's largest salt deposits.

India.—The government of India banned the exportation of soda ash from that country in the fall of 1975. There were protests from the Indian soda ash producers, and unsold stocks increased to 50,000 tons by December 1975. Prices of domestic soda ash and sodium bicarbonate were subsequently reduced.

Italy.—A new complex, which had an annual capacity of 260,000 tons of soda ash and sodium bicarbonate, was opened at Termini Imerese, Sicily, in 1975 by Orinoco. Capital costs of the project were $56.9 million.

U.S.S.R.—Soda ash production in the U.S.S.R. in the first half of 1975 was 8% higher than a comparable period of 1974, up to 2.5 million short tons.

TECHNOLOGY

A major soda ash producer developed a "double alkali" system for scrubbing sulfur dioxide from stack gases. The new procedure, which utilized a concentrated solution of sodium salts instead of limestone, will be tried in an industrial furnace in Pottstown, Pa.[3]

[3] Chemical & Engineering News. Concentrates. Firestone Will Evaluate FMC's Scrubbing System. V. 54, No. 2, Jan. 1, 1976, p. 30.

A waste solution from papermaking, which contained both soda ash and sodium sulfate, was retorted at high temperature and reduced to a mixed salt which was usable as an ingredient in glassmaking.

The Energy Research and Development Administration (ERDA) requested bids on an experimental metallic-sodium-filled cable, complete with splices and terminations, to carry a 138,000-volt current underground around Wolf Mill, Pa. If such a cable should be technologically and economically feasible, there would be a large new market for metallic sodium.

Stone

By Avery H. Reed [1]

Production of the stone industry declined from the record highs set in 1973–74. Output of dimension stone declined 27% to 1.40 million tons valued at $98.6 million. Production of crushed stone fell 13% to 901 million tons valued at $2.02 billion.

Leading stone producers were Vulcan Materials Co., 90 quarries; Martin Marietta Corp., 114 quarries; United States Steel Corp., 15 quarries; Lone Star Industries, Inc., 26 quarries; General Dynamics Corp., 7 quarries; U.S. Forest Service, 524 quarries; Medusa Aggregates Co., 48 quarries; Standard Industries, Inc., 19 quarries; The Flintkote Co., 28 quarries; and Mid-South Pavers, Inc., 17 quarries. These 10 companies operated 888 quarries and accounted for 22% of the total stone production.

Stone was produced in every State except Delaware. There were 2,259 companies, with 5,917 quarries or underground mines. Average output per company was 400,000 tons. Average production per quarry was 153,000 tons.

Since 1945 the total value of dimension stone production has multiplied five times, from $20 million to $100 million. Since 1945, the total output of crushed stone has multiplied seven times, from 150 million tons to 1 billion tons in 1974.

Classification.—The Bureau of Mines classifies stone into two categories, crushed and dimension; and into nine kinds—granite, limestone, marble, marl, sandstone, shell, slate, traprock, and miscellaneous.

The category classifications are not exact; some crushed stone may be in large pieces, such as riprap, and some dimension stone may be in small pieces, such as art objects or carvings. The dimension stone industry is concerned with cutting or shaping stone to a certain size, and waste or scrap from processing dimension stone may be a part of the crushed stone industry.

Classification by kind is also difficult. Granite may include metamorphic gneisses or syenites. Limestone may be pure calcium carbonate, but may be bituminous, dolomitic, or silicious. Marble may include any calcareous rock that will polish. Marl may range from low to high in shale or clay

[1] Supervisory physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient stone statistics in the United States

(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
Sold or used by producers:					
Dimension stone	1,626	1,490	1,582	1,915	1,403
Value	$93,132	$90,763	$85,999	$100,318	$98,586
Crushed stone	874,497	918,933	1,058,541	r 1,041,600	901,490
Value	$1,500,933	$1,581,530	$1,904,464	r $2,085,800	$2,024,000
Total stone	876,123	920,423	[1] 1,060,124	r 1,043,515	902,893
Value	$1,594,065	$1,672,293	$1,990,463	r $2,186,118	$2,122,586
Exports (value)	$11,489	$11,107	$13,063	$18,159	$22,125
Imports for consumption (value)	$33,643	$43,436	$48,678	$51,631	$45,625

r Revised.
[1] Data do not add to total shown because of independent rounding.

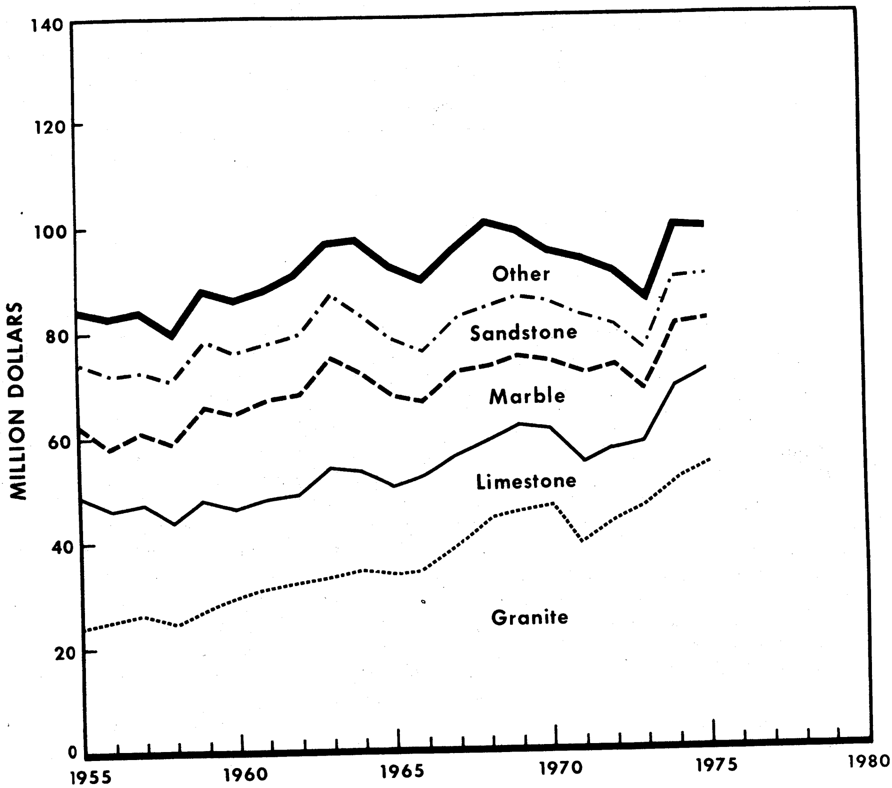

Figure 1.—Value of dimension stone sold or used by producers in the United States, by kind.

content. Sandstone may be calcareous, quartz or quartzite, silt or conglomerate. Miscellaneous stone includes aa, lava, schist, and any other stone not included in the aforementioned categories.

The Bureau of Mines generally accepts the classification reported by producers.

Deposits of unconsolidated materials, including beach sands, are generally classified as sand and gravel, regardless of chemical content. However, many deposits of stone are relatively soft, and may be mined without blasting. Natural sand deposits are classified as sand and gravel, but manufactured sand (stone sand) is classified as stone.

The Bureau of Mines canvass of dimension stone does not include processors of purchased rough stone. All producers are covered; if the producer sells rough stone to a processor, it is tabulated as rough stone; if the producer processes finished stone, only the finished stone is tabulated and the rough stone is deducted.

Capacity figures and stocks are not available. Inventories on hand at quarries and plants are estimated at about 1 month's supply, or 100 million tons.

DOMESTIC PRODUCTION

Dimension Stone.—Dimension stone was produced in 43 States. Leading States were Indiana, Georgia, Vermont, Ohio, and Pennsylvania, which together accounted for 56% of the total output. Of the total production, 43% was granite, 30% was

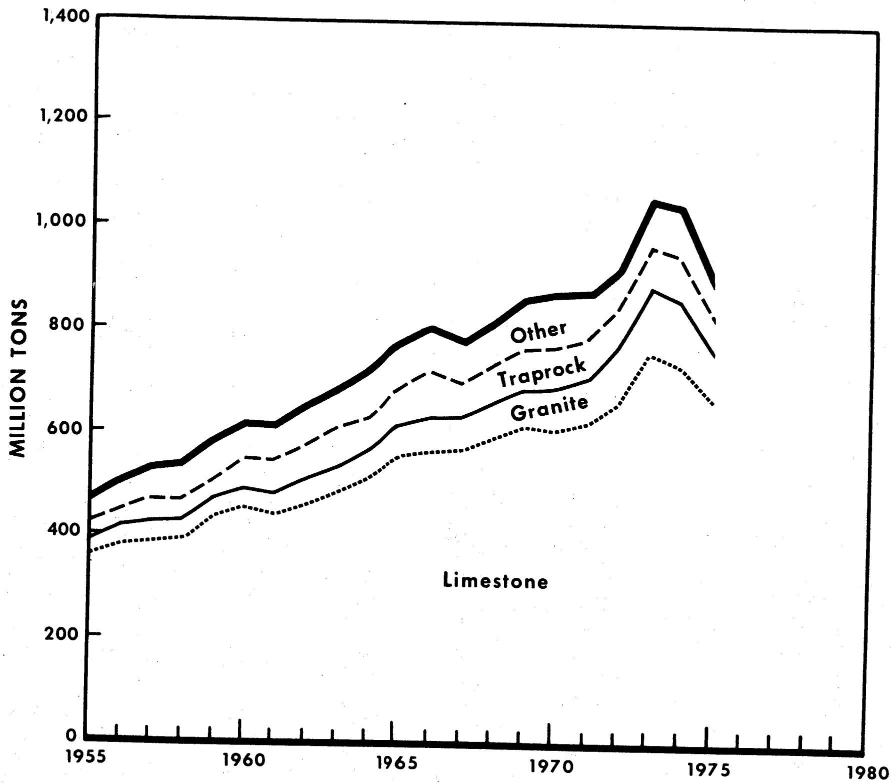

Figure 2.—Crushed stone sold or used by producers in the United States, by kind.

limestone, and 16% was sandstone. Leading companies were Coggins Granite Industries Inc., and Rock of Ages Corp. There were 309 companies; average output per company was 4,500 tons valued at $320,000. Total output of dimension stone was 1.40 million tons valued at $98.6 million.

Crushed Stone.—Crushed stone was produced in every State except Delaware. Leading States were Illinois, Pennsylvania, Texas, Missouri, and Ohio, which accounted for 30% of the total output. Of the total production, 74% was limestone, 10% was granite, and 9% was traprock. There were 2,001 companies; average output per company was 450,000 tons valued at $1.01 million. Leading companies were Vulcan Materials Co., Martin Marietta Corp., and United States Steel Corp. Total output of crushed stone was 901 million tons valued at $2.02 billion.

Table 2.—Dimension stone sold or used by producers in the United States, by State

State	1974			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Alabama	25,392	318,050	$2,445	27,395	351,630	$2,753
Arizona	4,300	61,722	116	4,734	64,647	148
Arkansas	9,989	124,860	253	4,784	59,800	159
California	368,090	4,358,300	2,172	10,759	130,120	490
Colorado	10,263	130,050	329	5,338	68,153	167
Connecticut	26,185	333,900	499	9,175	107,770	224
Georgia	239,560	2,458,300	11,841	249,700	2,546,100	12,345
Hawaii	10,360	110,870	105	10,154	107,300	102
Idaho	12,010	145,230	558	2,393	29,731	190
Illinois	2,742	32,260	70	3,479	40,929	79
Indiana	245,520	3,383,700	9,484	254,040	3,444,500	11,004
Iowa	14,692	171,270	391	13,075	153,840	409
Kansas	15,817	204,420	513	16,910	235,240	676
Maryland	21,036	262,960	469	23,353	296,080	612
Massachusetts	79,416	957,090	5,355	64,980	781,580	5,096
Michigan	5,589	70,116	117	7,357	90,989	138
Minnesota	34,843	416,870	7,841	42,765	510,040	10,058
Missouri	7,527	89,118	1,686	4,221	51,540	1,006
Nevada	841	10,257	20	W	W	W
New Hampshire	62,785	742,080	4,415	65,029	744,610	4,957
New Mexico	8,112	84,819	76	9,592	23,708	85
New York	33,876	338,260	2,752	34,524	371,630	2,178
North Carolina	57,913	675,870	3,559	46,937	532,860	3,502
Ohio	82,093	1,129,600	2,838	86,161	1,178,600	3,030
Oklahoma	15,445	184,840	637	20,508	238,330	1,007
Oregon	1,648	19,388	100	1,546	18,187	101
Pennsylvania	83,684	674,340	5,213	71,231	564,480	4,849
South Carolina	12,712	154,150	579	9,364	113,550	495
South Dakota	35,680	403,190	8,881	41,705	442,480	10,268
Tennessee	13,383	157,680	2,294	15,538	187,060	1,998
Texas	20,059	289,880	2,728	20,782	275,040	2,162
Utah	5,007	63,611	292	3,958	50,291	251
Vermont	145,107	1,312,000	12,329	120,214	1,064,600	10,935
Virginia	23,609	91,105	2,149	14,265	70,964	2,146
Washington	4,589	57,896	295	4,425	55,097	326
Wisconsin	164,420	2,018,100	6,461	69,248	836,460	4,119
Wyoming	2,376	28,291	60	1,904	19,923	50
Other States [1]	8,062	95,366	396	11,384	108,140	472
Total [2]	1,914,700	22,160,000	100,318	1,402,900	15,966,000	98,586
Puerto Rico	222,550	2,967,300	1,023	141,460	1,886,200	907

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Florida, Maine, Montana, New Jersey, Rhode Island, West Virginia (1975), and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

Table 3.—Crushed stone sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1974		1975	
	Quantity	Value	Quantity	Value
Alabama	23,773	60,231	22,225	58,762
Alaska	5,484	12,947	8,877	26,649
Arizona	4,928	11,363	3,399	10,882
Arkansas	20,371	38,652	17,414	38,637
California	45,341	89,719	33,141	72,251
Colorado	6,562	14,780	5,309	10,773
Connecticut	8,431	20,635	7,323	19,893
Florida	54,974	101,560	39,071	73,372
Georgia	40,082	93,741	29,834	78,812
Hawaii	7,638	21,370	7,559	25,217
Idaho	3,516	9,309	3,313	8,762
Illinois	63,229	121,690	60,637	130,020
Indiana	30,900	55,459	28,693	57,846
Iowa	32,327	65,728	30,323	73,324
Kansas	17,869	34,357	15,890	35,174
Kentucky	34,542	66,632	31,734	67,906
Louisiana	11,247	24,814	10,489	38,260
Maine	1,490	4,220	1,253	3,741
Maryland	18,051	47,162	14,772	42,498
Massachusetts	8,023	24,748	7,105	23,584
Michigan	47,474	72,631	39,938	73,662
Minnesota	8,266	14,201	6,812	13,244
Mississippi	1,720	2,572	1,629	2,730
Missouri	50,618	88,518	46,984	94,529
Montana	3,115	6,242	3,130	6,753
Nebraska	4,630	10,364	4,242	10,322
Nevada	2,185	4,183	1,829	4,524
New Hampshire	528	956	1,454	2,981
New Jersey	15,749	52,456	11,821	42,381
New Mexico	3,531	8,283	2,188	4,598
New York	38,173	84,972	31,678	78,751
North Carolina	34,704	71,583	28,261	65,825
North Dakota	--	--	30	153
Ohio	51,709	105,100	46,217	105,550
Oklahoma	22,213	35,962	20,090	35,832
Oregon	23,351	43,306	21,273	40,221
Pennsylvania	73,008	154,400	60,106	144,820
Rhode Island	429	1,352	293	1,125
South Carolina	14,187	24,968	13,826	29,587
South Dakota	2,933	5,349	2,605	5,082
Tennessee	41,707	73,252	39,923	81,439
Texas	63,074	109,760	57,964	104,390
Utah	2,864	6,118	2,482	5,916
Vermont	1,787	9,301	1,104	4,783
Virginia	44,152	93,839	35,369	82,058
Washington	15,091	24,188	7,915	18,428
West Virginia	10,954	22,308	10,583	24,332
Wisconsin	22,279	34,451	20,497	36,037
Wyoming	2,382	5,989	2,881	7,567
Total [1]	1,041,600	2,085,800	901,490	2,024,000
American Samoa	50	122	34	146
Guam	798	1,444	781	1,837
Puerto Rico	14,139	40,617	13,454	46,608
Virgin Islands	638	3,869	254	1,813

[1] Data may not add to totals shown because of independent rounding.

Table 4.—Crushed stone sold or used by producers in the United States, by size of operation

Size range (thousand short tons)	1974 Number of operations	1974 Sold or used: Thousand short tons	1974 Sold or used: Percent	1975 Number of operations	1975 Sold or used: Thousand short tons	1975 Sold or used: Percent
0 to 25	2,156	20,588	2	2,150	16,352	2
25 to 50	687	24,151	2	718	25,104	3
50 to 75	374	22,719	2	382	23,274	3
75 to 100	259	22,592	2	301	26,134	3
100 to 200	604	86,556	8	624	88,053	10
200 to 300	332	82,556	8	383	94,393	10
300 to 400	278	96,268	9	234	80,467	9
400 to 500	166	74,039	7	168	74,262	8
500 to 600	129	70,942	7	108	59,857	7
600 to 700	94	61,065	6	83	53,430	6
700 to 800	69	51,845	5	64	47,387	5
800 to 900	55	46,924	5	55	46,624	5
900 and above	228	r 381,380	37	157	266,150	29
Total [1]	5,431	r 1,041,600	100	5,425	901,490	100

r Revised.
[1] Data may not add to totals shown because of independent rounding.

Table 5.—Crushed stone sold or used by producers in the United States, by method of transportation

(Thousand short tons)

Method	1974 Quantity	1974 Percent	1975 Quantity	1975 Percent
Truck	r 828,560	79	723,550	80
Rail	94,439	9	77,883	9
Water	80,672	8	65,115	7
Other	r 37,959	4	34,942	4
Total [1]	r 1,041,600	100	901,490	100

r Revised.
[1] Data may not add to totals shown because of independent rounding.

LIMESTONE

Dimension.—Dimension limestone was produced by 67 companies in 18 States. Leading producing States were Indiana, Wisconsin, Alabama, Kansas, and Iowa, which accounted for 87% of the total output. Leading companies were Victor Oolitic Stone Co. and Indiana Limestone Co., Inc. Total output declined 19% to 420,000 tons valued at $18.3 million. Average production per company was 6,300 tons valued at $272,000.

Crushed.—Crushed limestone and dolomite was produced by 1,390 companies in 46 States. Leading States were Illinois, Texas, Pennsylvania, Missouri, and Ohio, which accounted for 38% of the total output. Leading companies were Vulcan Materials Co. and Martin Marietta Corp. Total limestone output declined 11% to 666 million tons. Average production per company was 480,000 tons valued at $1 million. There was no crushed limestone production in Delaware, Louisiana, New Hampshire, and North Dakota.

Table 6.—Dimension limestone sold or used by producers in the United States, by State

State	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
California	W	W	W	2,760	34,502	$51
Illinois	2,742	32,260	$70	3,479	40,929	79
Iowa	14,692	171,270	391	13,075	153,840	409
Kansas	15,817	204,420	513	16,910	235,240	676
Michigan	W	W	W	1,692	19,906	32
Texas	W	W	W	12,512	199,670	251
Virginia	1,041	12,247	44	928	10,917	W
Washington	1,769	22,113	53	1,694	21,175	52
Wisconsin	155,330	1,933,000	3,973	61,944	768,240	1,503
Other States 1	325,230	4,323,900	13,106	304,610	3,969,300	15,221
Total 2	516,620	6,699,200	18,150	419,600	5,453,700	18,274
Puerto Rico	222,550	2,967,300	1,023	141,463	1,886,200	907

r Revised. W Withheld to avoid disclosing individual company confidential data; included in "Other States."

1 Includes Alabama, Colorado, Florida, Indiana, Missouri, New Mexico, Ohio, Oklahoma, Rhode Island, and States indicated by symbol W.

2 Data may not add to totals shown because of independent rounding.

Table 7.—Crushed limestone sold or used by producers in the United States, by State
(Thousand short tons and thousand dollars)

State	1974 r		1975	
	Quantity	Value	Quantity	Value
Alabama	21,518	37,698	20,256	43,900
Alaska	W	W	1,821	8,730
Arizona	2,619	5,978	2,534	8,008
Arkansas	7,130	13,769	6,339	16,596
California	19,926	38,191	16,576	36,532
Colorado	4,427	10,519	3,920	7,744
Connecticut	198	1,366	175	1,310
Florida	54,560	100,380	38,556	72,034
Georgia	6,861	17,285	4,996	12,152
Hawaii	1,642	3,541	1,362	4,254
Idaho	364	793	368	821
Illinois	63,229	121,690	60,637	130,020
Indiana	30,741	54,702	28,665	57,806
Iowa	32,327	65,728	30,323	73,324
Kansas	17,335	33,244	15,382	33,704
Kentucky	34,447	66,237	W	W
Maine	1,085	2,729	817	2,314
Maryland	13,346	34,990	10,587	30,546
Michigan	46,451	68,129	38,642	68,669
Minnesota	6,472	10,721	5,003	9,549
Mississippi	960	1,551	1,067	1,823
Missouri	50,024	87,389	45,809	92,035
Montana	1,675	3,152	1,717	3,642
Nebraska	4,630	10,364	4,242	10,322
Nevada	1,587	3,012	1,667	4,224
New Mexico	2,242	5,619	1,534	3,147
New York	35,229	76,829	29,029	70,258
North Carolina	4,590	9,872	3,954	10,129
Ohio	50,085	99,517	44,940	98,358
Oklahoma	21,120	34,777	19,220	34,342
Oregon	512	1,125	W	W
Pennsylvania	57,715	121,290	46,020	109,470
South Dakota	W	W	1,876	3,120
Tennessee	41,504	72,178	39,915	81,289
Texas	55,483	90,108	52,801	91,019
Utah	2,001	4,681	1,871	4,680
Vermont	959	7,329	817	4,282
Virginia	20,098	40,325	17,850	39,650
Washington	794	1,372	753	1,496
West Virginia	10,223	20,575	10,065	22,887
Wisconsin	18,566	27,789	17,452	28,990
Wyoming	1,042	2,344	1,826	4,378
Other States 1	5,799	19,341	34,931	83,496
Total 2	751,520	1,428,200	666,320	1,421,000
American Samoa	50	122	34	146
Guam	798	1,444	781	1,837
Puerto Rico	10,546	21,682	10,127	25,984

r Revised.

W Withheld to avoid disclosing individual company confidential data; included with "Other States."

1 Includes Massachusetts, New Jersey, Rhode Island, South Carolina, and States indicated by symbol W.

2 Data may not add to totals shown because of independent rounding.

GRANITE

Dimension.—Dimension granite was produced by 83 companies in 21 States. Leading States were Georgia, Vermont, New Hampshire, Massachusetts, and South Dakota, which accounted for 79% of the total output. Leading companies were Coggins Granite Industries and Rock of Ages Corp. Output declined 8% to 604,000 tons valued at $54 million. Average production per company was 7,300 tons valued at $651,000.

Crushed.—Crushed granite was produced by 172 companies in 33 States. Leading States were Georgia, North Carolina, Virginia, South Carolina, and Arkansas, which accounted for 80% of the total output. Leading companies were Vulcan Materials Co. and Martin Marietta Corp. Output declined 20% to 94.3 million tons valued at $217 million. Average production per company was 548,000 tons valued at $1.26 million.

Table 8.—Dimension granite sold or used by producers in the United States, by State

State	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
California	45,278	552,180	$946	5,835	71,217	$377
Connecticut	2,426	29,296	125	4,358	45,997	160
Georgia	213,628	2,136,600	8,034	222,330	2,205,300	8,653
Massachusetts	79,416	957,090	5,355	64,980	781,580	5,096
Minnesota	18,512	215,370	6,072	22,482	261,870	7,780
Missouri	1,822	20,161	363	1,109	12,909	247
Nevada	841	10,257	20	W	W	W
New Hampshire	62,785	742,080	4,415	65,029	744,610	4,957
North Carolina	49,015	596,060	2,809	37,724	468,410	2,875
South Carolina	12,712	154,150	579	9,364	113,550	495
South Dakota	35,680	403,190	8,881	41,705	442,480	10,268
Texas	7,441	88,722	2,476	6,270	75,365	1,679
Vermont	96,224	993,790	7,447	81,177	842,970	7,025
Washington	20	242	1	30	364	1
Wisconsin	7,714	67,323	2,452	6,692	60,420	2,593
Other States [1]	24,244	289,620	1,426	34,533	388,700	1,837
Total [2]	657,760	7,256,200	51,401	603,620	6,515,700	54,042

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Colorado, Maine, New York, Oklahoma, Pennsylvania, Rhode Island (1974), Virginia, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

Table 9.—Crushed granite sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1974 r Quantity	1974 r Value	1975 Quantity	1975 Value
Alaska	542	1,580	1,174	5,300
Arizona	W	W	251	739
Arkansas	7,550	13,361	6,343	12,117
California	7,634	16,694	4,300	10,378
Colorado	1,614	2,972	928	1,929
Georgia	32,174	65,277	24,072	56,077
Idaho	299	569	39	100
Maine	--	--	35	93
Massachusetts	1,023	2,285	1,012	2,442
Minnesota	1,439	2,539	1,388	2,769
Montana	2	2	10	12
Nevada	497	915	149	278
New Mexico	19	36	196	474
North Carolina	28,155	56,999	22,303	50,973
Oklahoma	--	--	35	93
Oregon	58	141	W	W
Pennsylvania	529	1,522	W	W
South Carolina	10,000	17,831	9,948	22,529
Texas	180	375	1	1
Utah	9	9	W	W
Vermont	412	W	16	31
Virginia	17,192	35,229	12,590	28,437
Washington	318	603	360	780
Wisconsin	1,347	1,179	776	1,028
Other States [1]	7,567	18,022	8,332	20,410
Total [2]	118,560	238,140	94,258	216,990
Puerto Rico	--	--	29	66

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Connecticut, Maryland, Michigan, Missouri, New Hampshire, New Jersey, New York, Rhode Island, South Dakota (1974), Wyoming, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

TRAPROCK

Dimension.—Dimension traprock was produced by five companies in Hawaii, Washington, California, Virginia, and New Jersey. Leading companies were J. W. Glover, Ltd., and Heatherstone, Inc. Output was about the same as in 1974, 1,230 tons valued at $13,000. Average production per company was only 250 tons valued at $2,700.

Crushed.—Crushed traprock was produced by 288 companies in 25 States. Leading States were Oregon, New Jersey, Connecticut, Hawaii, and Washington, which accounted for 60% of the total output. Leading producers were the U.S. Forest Service and Standard Industries, Inc. Total output declined 19% to 78.4 million tons valued at $193 million. Average production per company was 273,000 tons valued at $669,000.

Table 10.—Crushed traprock sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1974 r		1975	
	Quantity	Value	Quantity	Value
Alaska	3,294	8,471	3,119	5,763
Arizona	1,070	2,253	41	62
California	6,101	11,174	4,390	8,617
Connecticut	7,971	17,942	6,988	17,774
Hawaii	5,637	17,102	5,967	20,265
Idaho	2,254	4,919	2,394	4,969
Massachusetts	6,102	16,201	5,362	15,261
Michigan	W	W	9	17
Montana	1,098	2,196	1,083	2,353
New Jersey	11,428	38,658	8,455	29,685
New Mexico	586	1,158	381	761
New York	2,196	6,232	1,527	5,055
North Carolina	W	W	1,612	3,948
Oregon	21,743	39,653	19,947	37,289
Pennsylvania	4,307	8,239	4,011	8,776
Virginia	4,610	10,683	3,429	8,252
Washington	12,929	19,188	5,581	12,279
Wisconsin	991	2,873	1,134	3,596
Other States [1]	4,568	10,958	3,013	7,880
Total [2]	96,885	217,900	78,443	192,600
Puerto Rico	1,236	2,672	1,222	2,862
Virgin Islands	638	3,869	213	1,490

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Maine, Maryland, Minnesota, New Hampshire, Texas, Vermont, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

SANDSTONE

Dimension.—Dimension sandstone was produced by 94 companies in 27 States. Leading States were Ohio, Pennsylvania, New York, Georgia, and Maryland, which accounted for 74% of the total output. Leading producers were The Flintkote Co. and Briar Hill Stone Co. Output declined 12% to 229,460 tons valued at $8 million. Average production per company was 2,400 tons valued at $85,000.

Crushed.—Crushed sandstone, quartz, and quartzite was produced by 197 companies in 35 States. Leading States were Arkansas, Pennsylvania, California, Alaska, Ohio, and Michigan, which accounted for 64% of the total output. Leading producers were the U.S. Forest Service and Ottaway Silica Co. Output declined 13% to 27.1 million tons valued at $77.2 million. Average production per company was 138,000 tons valued at $392,000.

Table 11.—Dimension sandstone sold or used by producers in the United States, by State

State	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Arizona	4,300	61,722	$116	4,734	64,647	$148
Arkansas	9,989	124,860	253	4,784	59,800	159
California	1,337	17,485	16	371	5,054	11
Colorado	8,517	109,250	194	4,946	63,440	123
Connecticut	23,759	304,600	374	4,817	61,769	64
Maryland	13,703	171,300	273	W	W	W
Michigan	W	W	W	5,665	71,083	106
Missouri	680	9,920	32	580	8,660	27
Montana	656	8,200	W	W	W	W
New York	24,979	298,490	1,785	27,970	334,160	1,539
Pennsylvania	41,430	530,720	1,095	30,501	390,870	865
Tennessee	6,373	81,706	369	9,536	122,280	299
Utah	4,457	57,141	272	W	W	W
Virginia	2,378	29,732	41	1,711	21,392	28
Washington	W	W	W	2,403	30,038	255
Wisconsin	1,381	17,705	35	612	7,800	23
Wyoming	321	4,115	5	150	1,923	2
Other States [1]	116,680	1,603,700	3,833	130,680	1,764,100	4,354
Total [2]	260,940	3,430,700	8,692	229,460	3,007,000	8,001

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Alabama, Georgia, Idaho, Indiana, Minnesota, New Jersey, New Mexico, North Carolina, Ohio, West Virginia, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

Table 12.—Crushed sandstone sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1974 r		1975	
	Quantity	Value	Quantity	Value
Alabama	19	96	57	228
Alaska	716	1,634	W	W
Arizona	1,092	2,409	456	1,429
Arkansas	5,435	9,991	5,325	9,375
California	4,854	10,497	3,451	7,856
Colorado	W	W	375	971
Florida	--	--	110	220
Idaho	472	2,819	482	2,736
Indiana	110	695	--	--
Maryland	279	1,284	313	1,387
Montana	211	637	262	665
New Mexico	141	401	W	W
New York	652	1,539	1,112	3,360
Ohio	1,624	5,581	1,277	7,192
Oregon	790	1,919	741	1,836
Pennsylvania	5,578	12,692	4,672	13,766
South Dakota	911	2,080	729	1,962
Texas	978	2,412	836	2,359
Utah	94	136	W	W
Vermont	32	78	29	50
Virginia	1,155	2,603	828	2,182
Washington	608	2,147	794	2,720
West Virginia	731	1,733	517	1,445
Wyoming	53	104	40	89
Other States [1]	4,556	14,329	4,714	15,409
Total [2]	31,090	77,815	27,120	77,237
Virgin Islands	--	--	41	323

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Connecticut, Georgia, Kansas, Kentucky, Maine, Michigan, Minnesota, Missouri, Nevada (1974), North Carolina, Oklahoma, Tennessee, Wisconsin, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

MARBLE

Dimension.—Dimension marble was produced by 15 companies in 13 States. Leading States were Vermont, Georgia, Tennessee, Alabama, and Montana, which accounted for 83% of the total output. Leading companies were Vermont Marble Co. and Georgia Marble Co. Output declined 32% to 50,000 tons valued at $9.5 million. Average production per company was 3,300 tons valued at $635,000.

Crushed.—Crushed marble was produced by 19 companies in 13 States. Leading States were Alabama, Georgia, North Carolina, Virginia, and Wyoming, which accounted for 91% of the total output. Leading companies were Georgia Marble Co. and Moretti-Harrah Marble Co. Output declined 13% to 1.5 million tons valued at $22.6 million. Average production per company was 77,000 tons valued at $1.19 million.

Table 13.—Dimension marble sold or used by producers in the United States, by State

State	1974			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Tennessee	7,010	75,975	$1,925	6,002	64,778	$1,699
Texas	--	--	--	2,000	20,000	232
Washington	60	714	2	57	685	2
Wyoming	2,055	24,176	55	1,754	18,000	47
Other States [1]	64,330	731,140	9,751	40,176	456,650	7,547
Total [2]	73,455	832,000	11,733	49,989	560,110	9,526

[1] Includes Alabama, Georgia, Idaho, Missouri, Montana, New Mexico, North Carolina, Utah, and Vermont.
[2] Data may not add to totals shown because of independent rounding.

Table 14.—Crushed marble sold or used by producers in the United States, by State
(Thousand short tons and thousand dollars)

State	1974		1975	
	Quantity	Value	Quantity	Value
Alabama	W	W	610	9,982
Colorado	1	4	--	--
Idaho	1	4	--	--
Vermont	1	1	4	6
Wyoming	65	1,625	54	1,340
Other States [1]	1,613	28,920	794	11,297
Total [2]	1,679	30,554	1,461	22,626
Puerto Rico	67	361	107	523

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Arizona, California, Georgia, Missouri, Nevada (1974), North Carolina, Tennessee, Texas, Utah, Virginia, Washington, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

SLATE

Dimension.—Dimension slate was produced by 32 companies in 7 States. Leading States were Pennsylvania, Vermont, Virginia, North Carolina, and New York. Leading producers were A. Dalley & Sons and Stoddard Slate Co., Inc. Output declined 21% to 61,900 tons valued at $7.5 million. Average production per company was 1,900 tons valued at $233,000.

Crushed.—Crushed slate was produced by nine companies in Virginia, Georgia, Arkansas, New York, and North Carolina. Leading producers were Georgia Lightweight Aggregate Co. and Solite Corp. Output declined 45% to 761,000 tons valued at $4.9 million. Average production per company was 85,000 tons valued at $549,000.

SHELL

Shell was produced by 17 companies in Louisiana, Texas, Alabama, Florida, South Carolina, California, and Virginia. Leading companies were Radcliff Materials, Inc., and Parker Bros. & Co., Inc. Output declined 15% to 15.5 million tons valued at $52.7 million. Average production per company was 909,000 tons valued at $3.1 million.

CALCAREOUS MARL

Marl was produced by 31 companies in 7 States. Leading States were South Carolina and Mississippi, which accounted for 78% of the total output. Leading companies were Santee Portland Cement Co. and Giant Portland Cement Co. Output declined 10% to 3.50 million tons valued at $4.87 million. Average production per company was 113,000 tons valued at $157,000.

MISCELLANEOUS STONE

Dimension.—Other kinds of dimension stone were produced by 23 companies in 10 States. Leading States were Maryland, Hawaii, Pennsylvania, Virginia, and New Jersey, which accounted for 89% of the total output. Leading producers were Joe's Moss Rock, Inc. and Stoneyhurst Quarries. Output declined 89% to 37,000 tons valued at $1.28 million. Average production per company was only 1,600 tons valued at $56,000.

Crushed.—Other crushed stone was produced by 89 companies in 28 States. Leading States were Pennsylvania, California, Alaska, Utah, and Oklahoma, which accounted for 82% of the total output. Leading producers were the U.S. Forest Service and Eureka Stone Quarry, Inc. Output declined 23% to 14.2 million tons valued at $31 million. Average production per company was 159,000 tons valued at $348,000.

Table 15.—Crushed calcareous marl sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1974 r		1975	
	Quantity	Value	Quantity	Value
Indiana	49	62	28	41
Michigan	151	258	85	153
Mississippi	760	1,021	561	907
North Carolina	243	847	228	461
South Carolina	W	W	2,180	2,778
Other States [1]	2,686	3,767	421	532
Total [2]	3,889	5,956	3,504	4,871

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Texas, Virginia, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

Table 16.—Crushed miscellaneous stone sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1974 r		1975	
	Quantity	Value	Quantity	Value
Alaska	827	988	1,391	3,899
California	6,718	12,763	4,409	8,693
Colorado	W	W	86	128
Hawaii	359	727	230	698
Idaho	127	205	30	136
Kansas	107	74	W	W
Missouri	90	147	W	W
Montana	130	255	58	81
Nevada	93	160	W	W
New Mexico	543	1,070	W	W
North Dakota	35	115	30	153
Oregon	248	467	200	331
Pennsylvania	4,879	10,744	W	W
Rhode Island	11	30	12	38
Utah	W	W	574	933
Vermont	84	86	76	114
Other States [1]	4,147	6,883	7,073	15,796
Total [2]	18,401	34,715	14,169	31,000
Puerto Rico	2,290	15,900	1,969	17,172

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Arizona, Arkansas, Louisiana, Maine (1974), Maryland, Massachusetts, Minnesota (1974), North Carolina (1975), Oklahoma, South Dakota (1974), Texas, Virginia, Washington, Wisconsin, Wyoming, and States indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Stone was consumed in every State. Some dimension stone was shipped to many States for use in buildings or as monuments. Most crushed stone was consumed in the State where it was produced. Many industries have grown up in the vicinity of stone quarries, such as cement mills or lime plants.

In the following descriptions of individual uses, output is considered to be the equivalent of consumption.

Dimension.—Dimension stone was used mainly for building and monumental stone. Stone sold as rough blocks decreased 11% to 293,600 tons valued at $9.6 million. Rough monumental stone output decreased 4% to 280,000 tons valued at $15.5 million. Output of cut, dressed building stone decreased 1% to 127,300 tons valued at $22.9 million. Output of curbing increased 1% to 123,000 tons valued at $7.8 million. Rubble production was 106,800 tons valued at $1.18 million. These five uses accounted for 66% of the total production.

Crushed.—Crushed stone was used mainly for building and road construction. It was also used in basic chemical industries, and for many other uses. Dense-graded roadbase stone production declined 12% to 216 million tons valued at $440 million. Output of coarse concrete aggregate declined 14% to 120 million tons valued at $261 million. Output of other construction aggregate and roadstone declined 9% to 117 million tons valued at $265 million. Production of stone used in cement decreased 17% to 95.5 million tons valued at $167 million. Output of bituminous aggregate declined 13% to 89.6 million tons valued at $226 million. These five uses accounted for 71% of the total production.

Table 17.—Dimension stone sold or used by producers in the United States, by use

Use	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough blocks	330,420	4,211,100	$10,381	293,580	3,688,400	$9,649
Rough monumental	293,020	3,004,500	15,354	279,960	2,815,300	15,540
Cut building stone	129,000	1,645,600	21,033	127,320	1,627,100	22,916
Curbing	121,790	1,452,600	7,882	122,980	1,455,000	7,789
Rubble	499,760	5,890,000	2,980	106,820	1,226,400	1,184
Rough building stone	90,378	1,147,700	2,006	99,971	1,254,700	2,101
Sawed building stone	124,790	1,641,900	7,197	89,405	1,197,200	5,421
House stone veneer	93,913	1,233,100	4,593	81,187	1,041,200	3,775
Dressed monumental	47,292	540,540	16,460	49,576	547,170	15,043
Rough flagging	48,113	602,270	1,729	36,225	458,580	1,425
Dressed building stone	17,425	212,150	852	31,231	397,560	4,826
Other dressed stone	9,739	22,415	613	6,283	17,930	709
Other rough stone	13,304	169,080	204	5,059	59,674	75
Other uses [1]	95,790	387,040	9,038	73,306	199,850	8,135
Total [2]	1,914,700	22,160,000	100,318	1,402,900	15,986,000	98,586

r Revised.
[1] Includes dressed flagging, sanitary fixtures, roofing slate, flooring slate, paving blocks, electrical fixtures, and blackboards.
[2] Data may not add to totals shown because of independent rounding.

Table 18.—Crushed stone sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	245,570	440,380	216,320	440,300
Concrete aggregate	139,290	276,560	119,660	261,350
Other aggregate and roadstone	128,870	264,020	117,150	264,880
Cement	115,400	177,100	95,506	167,200
Bituminous aggregate	102,850	225,996	89,552	225,800
Surface treatment aggregate	58,692	124,520	52,144	119,840
Agricultural limestone (agstone)	34,183	78,860	33,846	87,635
Lime	32,228	58,782	28,665	61,544
Macadam aggregate	34,157	62,908	27,955	57,977
Riprap	35,292	63,692	26,310	52,568
Flux stone	31,789	64,153	23,819	54,500
Railroad ballast	21,835	37,802	20,840	42,881
Stone sand	8,636	21,557	6,822	18,219
Fill	12,831	20,071	5,293	8,080
Roofing granules	4,353	11,267	4,381	11,236
Alkalies	2,285	5,276	3,214	7,045
Glass	3,137	15,723	3,000	16,252
Other fillers	2,583	28,217	2,888	27,459
Dead-burned dolomite	2,164	3,890	1,967	3,917
Poultry grit	2,632	12,749	1,962	11,450
Other chemicals	600	1,359	1,192	2,008
Sugar refining	928	3,014	1,163	3,578
Coal mine dusting	1,265	6,774	1,149	6,008
Whiting	1,477	22,964	1,014	17,050
Refractories	959	4,734	965	6,631
Ferrosilicon	480	1,816	932	2,455
Asphalt filler	1,153	5,980	751	3,745
Filter stone	1,954	4,300	727	1,888
Agricultural marl	543	1,467	584	1,765
Terrazzo	314	4,622	584	7,259
Lightweight aggregate	983	6,822	510	4,107
Waste products	717	707	401	439
Building products	162	318	260	642
Bedding material	220	414	161	316
Paper	189	668	135	611
Drain fields	188	350	86	187
Abrasives	225	1,290	81	707
Acid neutralization	368	875	55	180
Other uses [1]	10,099	23,804	9,446	24,291
Total [2]	1,041,600	2,085,800	901,490	2,024,000

r Revised.
[1] Includes carbon dioxide (1975), porcelain, flour (slate), stucco, disinfectant, and other uses.
[2] Data may not add to totals shown because of independent rounding.

LIMESTONE

Dimension.—Dimension limestone was used mainly as building stone. Sales of rough limestone blocks declined 21% to 162,400 tons valued at $4.04 million. Output of house stone veneer declined 12% to 55,600 tons valued at $2.3 million. Production of sawed, dressed building stone declined 16% to 54,500 tons valued at $3.4 million. Production of cut building stone increased 5% to 54,300 tons valued at $6.9 million. Output of rubble declined 54% to 36,700 tons valued at $427,000. These five uses accounted for 87% of the total output.

Crushed.—Output of dense-graded roadbase stone declined 10% to 152 million tons valued at $290 million. Production of concrete aggregate declined 10% to 94.3 million tons valued at $199 million. Output of crushed limestone for cement declined 16% to 88.3 million tons valued at $151 million. Production of other aggregates and roadstone declined 5% to 73.1 million tons valued at $151 million. Output of bituminous aggregate declined 7% to 57.8 million tons valued at $140 million. These five uses accounted for 70% of the total output of crushed limestone.

Table 19.—Dimension limestone sold or used by producers in the United States, by use

Use	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough blocks	206,170	2,775,300	$4,272	162,400	2,173,700	$4,045
House stone veneer	63,438	825,070	2,580	55,650	732,880	2,267
Sawed dressed building stone	64,812	876,930	3,832	54,467	742,200	3,416
Cut, dressed building stone	51,976	680,990	5,673	54,339	723,490	6,941
Rubble	80,339	918,660	834	36,716	373,460	427
Rough building stone	18,966	238,510	330	25,203	320,630	530
Rough flagging	15,615	197,780	283	16,216	207,460	301
Dressed building stone	11,475	138,540	239	10,786	131,720	248
Dressed flagging	2,038	25,163	66	2,001	25,378	78
Other uses [1]	1,790	22,252	41	1,832	22,777	20
Total [2]	516,620	6,699,200	18,150	419,600	5,453,700	18,274

r Revised.
[1] Includes curbing, other rough stone, other dressed stone, and dressed monumental stone (1974).
[2] Data may not add to totals shown because of independent rounding.

Table 20.—Crushed limestone sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	168,470	283,110	151,760	290,210
Concrete aggregate	105,190	202,800	94,305	198,640
Cement	105,250	157,860	88,326	151,010
Other aggregate and roadstone	76,563	145,830	73,097	151,400
Bituminous aggregate	62,239	130,420	57,816	140,290
Surface treatment aggregate	46,603	98,585	38,398	88,586
Agricultural limestone (agstone)	32,469	75,044	33,570	86,888
Lime	31,728	58,129	27,663	58,416
Macadam aggregate	29,374	53,856	23,777	48,685
Fluxing stone	30,663	59,319	22,756	49,707
Riprap	19,382	33,901	13,718	28,333
Railroad ballast	9,677	16,569	9,482	18,653
Stone sand	5,393	12,937	4,363	11,087
Alkalies	2,285	5,276	3,209	6,990
Fill	2,644	4,490	2,094	2,997
Glass	1,714	8,395	2,021	10,207
Dead-burned dolomite	2,164	3,890	1,967	3,917
Other fillers	1,607	11,591	1,892	14,200
Poultry grit	2,141	10,085	1,616	10,015
Other chemicals	600	1,359	1,192	2,008
Sugar refining	928	3,014	1,163	3,578
Coal mine dusting	1,265	6,774	1,149	6,008
Whiting	958	13,390	744	11,537
Asphalt filler	1,007	5,465	658	3,277
Waste products	644	573	401	439
Agricultural marl	406	1,179	377	1,288
Filter stone	1,305	2,729	294	721
Roofing granules	186	720	278	1,046
Terrazzo	189	1,180	175	1,364
Paper	189	668	135	611
Building products	125	250	110	209
Bedding material	195	365	79	143
Refractories	402	848	76	277
Drain fields	164	280	56	109
Acid neutralization	368	875	55	180
Other uses [1]	7,033	16,444	7,539	17,939
Total [2]	751,520	1,428,200	666,320	1,421,000

r Revised.
[1] Includes ferrosilicon, carbon dioxide (1975), abrasives, stucco, disinfectant, porcelain (1974), and other uses.
[2] Data may not add to totals shown because of independent rounding.

Table 21.—Crushed limestone sold or used by producers in the United States in 1975, by State and use

(Thousand short tons and thousand dollars)

State	Aggregates [1]		Cement		Agricultural limestone		Lime [2]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	10,819	21,060	3,348	5,470	1,226	4,833	2,003	6,359
Alaska	1,821	8,730	--	--	--	--	--	--
Arizona	95	243	W	W	W	W	465	1,603
Arkansas	3,110	10,426	W	W	551	1,388	W	W
California	3,246	6,902	11,008	18,107	46	272	523	1,324
Colorado	W	W	W	W	W	W	W	W
Connecticut	--	--	--	--	61	407	W	W
Florida	32,202	58,562	1,446	2,023	942	3,112	W	W
Georgia	3,185	7,896	1,323	2,130	W	W	--	--
Hawaii	274	1,175	910	1,916	28	120	W	W
Idaho	--	--	W	W	--	--	--	--
Illinois	49,028	103,470	2,394	4,069	5,712	12,010	832	1,779
Indiana	22,224	45,510	2,801	3,868	2,498	5,202	--	--
Iowa	21,505	52,590	3,268	6,208	3,265	8,189	W	W
Kansas	10,866	25,349	3,154	5,926	694	1,292	W	W
Kentucky	24,610	51,849	940	1,624	2,059	4,706	W	W
Maine	122	453	W	W	W	W	--	--
Maryland	8,087	21,379	1,868	2,331	W	W	29	W
Michigan	8,908	16,188	7,334	12,253	516	1,022	8,707	14,932
Minnesota	4,191	7,742	--	--	391	873	W	W
Mississippi	W	W	756	1,134	W	W	--	--
Missouri	27,837	58,890	5,492	7,996	4,385	10,029	3,067	4,913
Montana	42	85	W	W	--	--	286	838
Nebraska	2,851	6,692	W	W	169	361	--	--
Nevada	230	184	W	W	--	--	W	W
New Mexico	741	1,397	W	W	--	--	57	W
New York	20,753	51,939	5,409	8,944	306	1,491	2	W
North Carolina	3,210	8,152	W	W	W	W	--	--
Ohio	26,061	54,501	4,107	9,799	2,485	6,362	3,587	6,114
Oklahoma	14,527	26,054	1,932	2,712	397	712	--	--
Pennsylvania	28,206	61,968	7,089	13,958	1,707	6,948	3,471	8,665
South Dakota	934	1,859	W	W	W	W	W	W
Tennessee	33,273	66,410	1,811	3,692	2,286	4,774	W	W
Texas	39,393	68,232	6,901	8,982	242	381	2,350	4,256
Utah	W	W	929	2,089	W	W	W	W
Vermont	408	836	--	--	126	505	--	--
Virginia	11,646	23,860	1,226	2,257	1,601	4,635	1,524	3,438
Washington	W	W	W	W	10	W	--	--
West Virginia	6,576	15,371	W	W	77	299	W	W
Wisconsin	14,903	23,530	--	--	1,065	2,571	W	W
Wyoming	761	1,367	W	W	--	--	W	W
Other States [3]	2,509	7,048	12,881	23,520	728	4,394	2,728	8,113
Total [4]	439,160	917,897	88,326	151,010	33,570	86,888	29,630	62,333
American Samoa	34	146	--	--	--	--	--	--
Guam	753	1,777	--	--	--	--	--	--
Puerto Rico	7,125	20,479	W	W	--	--	W	W

State	Riprap		Fluxing stone		Railroad ballast		Other uses [5]		Total [4]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	432	1,023	1,318	2,581	94	179	1,016	2,395	20,256	43,900
Alaska	--	--	--	--	--	--	--	--	1,821	8,730
Arizona	--	--	548	1,934	--	--	1,426	4,228	2,534	8,008
Arkansas	54	81	847	1,041	--	--	1,777	3,660	6,339	16,596
California	50	112	W	W	--	--	1,704	9,814	16,576	36,532
Colorado	W	W	W	W	W	W	3,920	7,744	3,920	7,744
Connecticut	--	--	--	--	--	--	114	903	175	1,310
Florida	159	451	--	--	W	W	3,807	7,886	38,556	72,034
Georgia	14	27	--	--	W	W	474	2,099	4,996	12,152
Hawaii	--	--	--	--	--	--	150	1,043	1,362	4,254
Idaho	W	W	--	--	--	--	368	821	368	821
Illinois	775	1,647	309	623	400	765	1,188	5,662	60,637	130,020
Indiana	250	598	W	W	271	513	621	2,114	28,665	57,806
Iowa	320	747	W	W	1,078	2,195	886	3,395	30,323	73,324
Kansas	409	601	--	--	W	W	259	536	15,382	33,704
Kentucky	2,313	5,126	W	W	373	780	W	W	W	W
Maine	28	65	--	--	W	W	667	1,796	817	2,314
Maryland	148	560	W	W	W	W	455	6,277	10,587	30,546
Michigan	255	409	10,192	19,356	278	496	2,452	4,013	38,642	68,669
Minnesota	60	133	--	--	W	W	361	801	5,003	9,549
Mississippi	W	W	--	--	W	W	311	689	1,067	1,823
Missouri	3,400	5,349	W	W	135	369	1,493	4,489	45,809	92,035
Montana	5	9	312	715	81	206	990	1,789	1,717	3,642
Nebraska	104	350	--	--	W	W	1,118	2,919	4,242	10,322
Nevada	24	47	W	W	--	--	1,413	3,993	1,667	4,224
New Mexico	173	221	W	W	--	--	563	1,529	1,534	3,147
New York	682	1,870	W	W	175	397	1,702	5,617	29,029	70,268
North Carolina	W	W	--	--	W	W	744	1,977	3,954	10,129
Ohio	903	2,223	4,022	8,365	1,453	2,736	2,322	8,258	44,940	98,358
Oklahoma	1,013	1,594	--	--	1,018	1,773	333	1,497	19,220	34,342
Pennsylvania	321	778	2,729	8,772	695	1,783	1,802	6,598	46,020	109,470
South Dakota	4	4	--	--	102	188	836	1,069	1,876	3,120
Tennessee	634	1,328	W	W	234	427	1,677	4,658	39,915	81,289
Texas	598	1,541	362	1,242	940	1,673	2,010	4,712	52,801	91,019
Utah	3	3	W	W	W	W	939	2,588	1,871	4,680
Vermont	24	48	--	--	W	W	259	2,893	817	4,282
Virginia	31	63	211	430	354	647	1,257	4,320	17,850	39,650
Washington	W	W	W	W	--	--	743	1,496	753	1,496
West Virginia	31	94	W	W	646	1,062	2,735	6,061	10,065	22,887
Wisconsin	377	895	W	W	95	170	1,012	1,824	17,452	28,990
Wyoming	4	W	--	--	668	W	393	3,011	1,826	4,378
Other States [3]	123	338	1,907	4,648	391	2,294	4,636	19,412	34,931	83,496
Total [4]	13,718	28,333	22,756	49,707	9,482	18,653	50,936	156,580	666,320	1,421,000
American Samoa	--	--	--	--	--	--	--	--	34	146
Guam	3	6	--	--	--	--	25	53	781	1,836
Puerto Rico	W	W	--	--	--	--	3,002	5,505	10,127	25,984

W Withheld to avoid disclosing individual company confidential data; included with "Other uses" and "Other States."

[1] Includes all aggregates.

[2] Includes dead-burned dolomite.

[3] Includes Massachusetts, New Jersey, Oregon, Rhode Island, South Carolina, and States indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

[5] Includes stone sand, alkalies, fill, glass, other fillers, other uses, and uses indicated by symbol W.

GRANITE

Dimension.—Dimension granite was used mainly for monumental and building stone. Output of rough monumental stone declined 5% to 279,400 tons valued at $15.5 million. Production of curbing increased 1% to 122,400 tons valued at $7.76 million. Sales of rough granite blocks increased 30% to 60,800 tons valued at $2.21 million. Output of dressed monumental stone increased 37% to 46,400 tons valued at $14.1 million. Production of cut building stone increased 14% to 38,600 tons valued at $12.2 million. These five uses accounted for 91% of the total output of dimension granite.

Crushed.—Output of dense-graded roadbase stone declined 14% to 30.1 million tons valued at $67.8 million. Production of concrete aggregate declined 26% to 15.9 million tons valued at $36.9 million. Output of bituminous aggregate declined 17% to 15.1 million tons valued at $37.9 million. Production of other aggregates and roadstone declined 27% to 12.4 million tons valued at $28.2 million. Output of crushed granite for use as railroad ballast declined 5% to 7.43 million tons valued at $15.8 million. These five uses accounted for 86% of the total output of crushed granite.

Table 22.—Dimension granite sold or used by producers in the United States, by use

Use	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough monumental	292,910	3,003,200	$15,336	279,462	2,808,600	$15,530
Curbing	121,260	1,445,400	7,844	122,439	1,448,200	7,761
Rough blocks	46,643	483,950	1,550	60,794	630,700	2,206
Dressed monumental	33,901	388,020	11,962	46,379	510,240	14,103
Cut, dressed building stone	33,998	412,700	11,370	38,601	466,200	12,244
Rubble	80,224	944,180	616	19,481	213,630	158
Sawed, dressed building stone	26,959	315,480	1,455	12,889	156,330	350
Dressed construction stone	4,224	52,634	553	8,066	99,636	1,085
Rough construction stone	8,400	100,010	238	6,430	77,349	193
House stone veneer	1,797	21,406	75	1,664	19,791	102
Rough flagging	1,158	13,583	61	387	4,707	12
Other uses [1]	6,286	75,659	340	7,027	80,328	298
Total [2]	657,760	7,256,200	51,401	603,620	6,515,700	54,042

r Revised.
[1] Includes paving blocks, dressed flagging, other rough stone, and other dressed stone.
[2] Data may not add to totals shown because of independent rounding.

Table 23.—Crushed granite sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	35,137	69,506	30,139	67,759
Concrete aggregate	21,518	43,014	15,900	36,868
Bituminous aggregate	18,123	38,501	15,113	37,913
Other aggregate and roadstone	16,998	33,427	12,409	28,177
Railroad ballast	7,816	13,962	7,433	15,767
Surface treatment aggregate	5,144	10,984	4,173	9,714
Riprap	2,761	5,987	2,457	7,031
Macadam aggregate	3,642	6,835	2,452	4,740
Roofing granules	1,580	2,691	1,597	2,849
Stone sand	1,815	3,436	1,365	3,076
Filter stone	390	989	147	383
Fill	2,446	6,671	131	194
Terrazzo	17	233	115	669
Poultry grit	42	389	81	433
Bedding material	14	21	4	13
Other uses [1]	1,112	1,495	742	1,406
Total [2]	118,560	238,140	94,258	216,990

r Revised.
[1] Includes asphalt filler, cement (1974), building products (1974), and other uses.
[2] Data may not add to totals shown because of independent rounding.

TRAPROCK

Dimension.—Dimension traprock was used for rubble (88%), sold as rough blocks, and used as rough building stone.

Crushed.—Output of dense-graded roadbase stone declined 15% to 19.2 million tons valued at $43.6 million. Production of other aggregates and roadstone declined 29% to 17.3 million tons valued at $45.8 million. Output of bituminous aggregate declined 14% to 12.5 million tons valued at $35.8 million. Production of surface treatment aggregate increased 54% to 7.4 million tons valued at $16.4 million. Output of riprap declined 19% to 7.07 million tons valued at $11.0 million. These five uses accounted for 81% of the total output of crushed traprock.

Table 24.—Crushed traprock sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	22,485	47,655	19,152	43,634
Other aggregate and roadstone	24,375	61,422	17,258	45,818
Bituminous aggregate	14,598	38,765	12,511	35,803
Surface treatment aggregate	4,809	9,812	7,399	16,443
Riprap	8,771	15,732	7,066	11,049
Concrete aggregate	8,530	21,537	6,880	18,817
Railroad ballast	2,155	4,139	2,558	5,991
Roofing granules	1,706	4,332	1,650	4,677
Fill	6,126	6,578	1,248	1,684
Macadam aggregate	852	1,727	1,180	3,398
Stone sand	810	1,872	536	2,084
Filter stone	192	407	222	643
Bedding material	4	16	57	117
Drain fields	16	44	27	69
Other uses [1]	1,456	3,862	699	2,376
Total	96,885	217,900	78,443	[2] 192,600

r Revised.

[1] Includes other fillers, asphalt fillers, building products, poultry grit (1974), waste materials (1974), and other uses.

[2] Data do not add to total shown because of independent rounding.

SANDSTONE

Dimension.—Dimension sandstone was used mainly for building stone. Output of rough building stone increased 18% to 51,500 tons valued at $974,000. Sales of rough blocks increased 12% to 43,600 tons valued at $868,000. Output of rubble increased 6% to 35,300 tons valued at $395,000. Production of cut building stone declined 11% to 25,800 tons valued at $1.75 million. Output of house stone veneer declined 15% to 20,300 tons valued at $705,000. These five uses accounted for 77% of the total output of dimension sandstone.

Table 25.—Dimension sandstone, quartz and quartzite sold or used by producers in the United States, by use

Use	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough building stone	43,685	579,360	$922	51,506	654,620	$974
Rough blocks	39,081	528,570	792	43,632	589,260	868
Rubble	33,356	433,010	392	35,320	466,150	395
Cut building stone	29,186	380,590	1,566	25,835	337,050	1,750
House stone veneer	23,813	317,750	791	20,346	272,790	705
Sawed building stone	31,742	435,880	1,625	20,186	278,530	1,208
Rough flagging	28,771	360,650	1,338	19,524	245,220	1,108
Dressed flagging	17,021	212,580	696	8,700	107,320	414
Other uses [1]	14,285	182,310	570	4,412	56,086	580
Total [2]	260,940	3,430,700	8,692	229,460	3,007,026	8,001

r Revised.

[1] Includes dressed construction stone, rough monumental, other rough stone, curbing, dressed monumental, and other dressed stone.

[2] Data may not add to totals shown because of independent rounding.

Crushed.—Output of dense-graded roadbase stone declined 21% to 6.4 million tons valued at $13.9 million. Production of other aggregates and roadstone declined 10% to 5.59 million tons valued at $12.5 million. Output of bituminous aggregate declined 27% to 2.34 million tons valued at $6.48 million. Production of concrete aggregate increased 2% to 2.18 million tons valued at $6.07 million. Output of riprap declined 27% to 1.81 million tons valued at $3.95 million. These five uses accounted for 68% of the total output of crushed sandstone.

Table 26.—Crushed sandstone sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974		1975	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	8,082	15,734	6,401	13,914
Other aggregate and roadstone	6,178	12,679	5,588	12,515
Bituminous aggregate	3,207	7,642	2,345	6,482
Concrete aggregate	2,135	5,171	2,185	6,068
Riprap	2,481	4,933	1,812	3,954
Surface treatment aggregate	737	1,770	1,392	3,482
Flux stone	1,126	4,834	1,063	4,793
Glass	1,423	7,327	979	6,045
Railroad ballast	1,168	2,205	962	2,008
Refractories	558	3,886	889	6,354
Cement	752	1,654	718	1,936
Roofing granules	674	1,487	684	1,623
Stone sand	533	2,068	554	1,914
Fill	272	441	477	919
Macadam aggregate	218	371	329	811
Building products	30	55	149	431
Abrasives	110	991	61	528
Filter stone	60	150	37	78
Terrazzo	28	497	14	117
Other uses [1]	1,318	3,920	481	3,264
Total	31,090	77,815	27,120	[2] 77,237

[1] Includes porcelain, ferrosilicon, other fillers, bedding material (1975), poultry grit, drain fields, waste material (1974), and other uses.
[2] Data do not add to total shown because of independent rounding.

MARBLE

Dimension.—Dimension marble was used mainly for building stone. Sales of rough blocks declined 24% to 25,700 tons valued at $2.49 million. Output of cut building stone declined 44% to 4,850 tons valued at $1.64 million. Production of sawed building stone increased 13% to 1,300 tons valued at $300,000. Of the total production, 51% was sold as rough blocks.

Crushed.—Crushed marble was used mainly as a filler or as whiting. Output of other filler increased 3% to 747,000 tons valued at $11.4 million. Production of terrazzo was 234,000 tons valued at $4.76 million, a decrease of 2%. Of the total output of crushed marble, 51% was used for other filler.

Table 27.—Dimension marble sold or used by producers in the United States, by use

Use	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough blocks	33,912	371,000	$3,560	25,665	281,990	$2,491
Cut, dressed building stone	8,678	104,440	1,962	4,851	57,077	1,636
House stone veneer	W	W	W	2,853	10,244	679
Sawed, dressed building stone	1,169	12,419	269	1,323	14,141	300
Other uses [1]	29,696	344,140	5,942	15,297	196,660	4,420
Total [2]	73,455	832,000	11,733	49,989	560,110	9,526

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes dressed construction stone, dressed monumental stone, rubble, rough building stone, dressed flagging, rough flagging, and uses indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

Table 28.—Crushed marble sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Other filler	726	15,643	747	11,386
Terrazzo	238	3,294	234	4,759
Roofing granules	W	W	47	513
Other uses [1]	715	11,617	433	5,968
Total	1,679	30,554	1,461	22,626

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

[1] Includes whiting, dense-graded roadbase stone (1975), other aggregates and roadstone, concrete aggregate (1975), riprap, stone sand, poultry grit, and other uses (1974).

SLATE

Dimension.—Dimension slate was used mainly for flagging, roofing, and flooring. Output of flagging declined 14% to 25,300 tons valued at $1.06 million. Production of structural and sanitary fixtures declined 29% to 11,800 tons valued at $2.42 million. Output of roofing slate declined 20% to 11,000 tons valued at $2.17 million. Output of slate for flooring declined 14% to 6,300 tons valued at $969,000. These four uses accounted for 88% of the total production of dimension slate.

Crushed.—Crushed slate was used for lightweight aggregate (67%), roofing granules, and other uses. Total output declined 45% to 761,000 tons valued at $4.94 million.

Table 29.—Dimension slate sold or used by producers in the United States, by use

Use	1974 r		1975	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Flagging	29,396	$1,288	25,269	$1,055
Sanitary fixtures	16,592	2,536	11,835	2,417
Roofing	13,744	2,146	11,003	2,166
Flooring	7,267	1,146	6,274	969
Billiard tables	2,807	614	1,987	457
Electrical fixtures	W	W	340	56
Blackboards	459	177	264	136
Other uses [1]	8,425	316	4,961	196
Total	78,690	8,223	61,933	[2] 7,453

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

[1] Includes house stone veneer, monumental stone, other uses, and uses indicated by symbol W.

[2] Data do not add to total shown because of independent rounding.

SHELL

Output of roadstone was 6.18 million tons valued at $22.1 million, considerably more than in 1974. Shell used in cement declined 39% to 3.72 million tons valued at $10.8 million. Production of roadbase stone declined 50% to 3.49 million tons valued at $11.7 million. Shell used in lime was 993,000 tons valued at $3.12 million, considerably more than in 1974. These four uses accounted for 93% of the total shell output.

CALCAREOUS MARL

Marl was used mainly for cement and soil conditioning. Marl used in cement declined 15% to 2.69 million tons valued at $3.36 million. Output of agricultural marl declined 8% to 486,000 tons valued at $966,000. These two uses accounted for 90% of the total marl output.

Table 30.—Crushed shell sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Other aggregate and roadstone	2,262	6,322	6,182	22,068
Cement	6,155	13,105	3,725	10,806
Dense-graded roadbase stone	6,903	14,918	3,486	11,690
Lime	487	616	993	3,122
Bituminous aggregate	W	W	252	1,057
Concrete aggregate	W	W	10	20
Other uses [1]	2,428	8,665	806	3,908
Total	18,235	43,626	[2] 15,453	52,671

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other uses."
[1] Includes poultry grit, agstone, riprap, railroad ballast, surface treatment aggregate, and other uses.
[2] Data do not add to total shown because of independent rounding.

MISCELLANEOUS STONE

Dimension.—Miscellaneous dimension stone was used mainly as building stone. Output of rough building stone expanded 76% to 16,200 tons valued at $365,000. Rubble production was 12,000 tons valued at $133,000. Output of cut building stone declined 28% to 3,700 tons valued at $345,000. These three uses accounted for 86% of the total output.

Crushed.—Output of roadbase stone increased 27% to 5.57 million tons valued at $13.5 million. Output of roadstone increased 10% to 2.46 million tons valued at $4.66 million. Production of bituminous aggregates declined 62% to 1.65 million tons valued at $4.52 million. Stone used for fill decreased 5% to 1.28 million tons valued at $2.23 million. Output of riprap declined 34% to 1.21 million tons valued at $1.94. These five uses accounted for 86% of the total production of miscellaneous stone.

Table 31.—Other dimension stone sold or used by producers in the United States, by use

Use	1974 r			1975		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough building stone	9,220	111,000	$239	16,202	194,670	$365
Rubble	302,041	3,560,600	1,051	12,020	147,330	133
Cut building stone	5,158	66,877	461	3,694	43,265	345
Rough blocks	4,511	51,015	200	979	11,364	31
House stone veneer	1,519	31,415	48	471	5,540	18
Rough flagging	2,532	29,819	47	79	969	3
Other uses [1]	1,097	12,874	43	3,636	62,172	380
Total [2]	326,080	3,863,600	2,089	37,081	465,310	1,277

r Revised.
[1] Includes dressed construction stone, sawed building stone, sanitary fixtures (1975), dressed flagging, curbing (1975), and other rough stone (1975).
[2] Data may not add to totals shown because of independent rounding.

Table 32.—Other crushed stone sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1974 r		1975	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	4,402	9,149	5,571	13,460
Other aggregate and roadstone	2,232	3,899	2,465	4,660
Bituminous aggregate	4,369	9,379	1,646	4,516
Fill	1,339	1,886	1,277	2,234
Riprap	1,836	2,864	1,211	1,942
Surface treatment aggregate	739	1,204	705	1,484
Railroad ballast	1,010	880	389	381
Concrete aggregate	1,923	4,036	386	908
Macadam aggregate	71	119	218	344
Terrazzo	41	218	46	349
Roofing granules	43	156	46	223
Filter stone	7	25	27	63
Other uses [1]	389	900	182	436
Total	18,401	34,715	14,169	31,000

r Revised.

[1] Includes cement, other fillers, alkalies (1975), drain fields, bedding materials, building products, abrasives (1974), stone sand (1974), asphalt filler (1974), and other uses.

PRICES

Values reported to the Bureau of Mines represent the average selling prices f.o.b. mine or plant and do not include transportation away from the plant.

Unit values for dimension stone ranged from $11.09 per ton for rubble to $516.16 per ton for stone used for blackboards, and averaged $70.27 per ton, an increase of 34% over 1974. Values, per cubic foot, were: $2.62 for rough blocks; $5.52 for rough monumental stone; $14.08 for cut building stone; $5.35 for curbing; and $0.98 for rubble.

Unit values for crushed stone ranged from $1.09 per ton for waste material to $16.82 per ton for whiting, and averaged $2.35 per ton, an increase of 18% over 1974. Values for roadbase stone were $2.04 per ton; coarse concrete aggregate, $2.18; roadstone, $2.26; stone used in cement, $1.75; and bituminous aggregate, $2.52 per ton.

Unit values for dimension limestone averaged $43.55 per ton or $3.35 per cubic foot; crushed limestone value averaged $2.13 per ton. Value of dimension granite averaged $89.53 per ton or $8.29 per cubic foot; crushed granite averaged $2.30 per ton. Crushed traprock value averaged $2.46 per ton. Dimension sandstone averaged $34.87 per ton or $2.66 per cubic foot; crushed sandstone, quartz, and quartzite averaged $2.85 per ton. Dimension marble value averaged $190.56 per ton or $18.24 per cubic foot; crushed marble was $15.49 per ton. The average value for dimension slate was $120.34 per ton, and $6.50 per ton for crushed slate. Shell sold for $3.41 per ton, and marl was valued at $1.39 per ton. Miscellaneous stone was valued at $34.44 per ton or $2.74 per cubic foot for dimension stone, and $2.19 per ton for crushed stone.

FOREIGN TRADE

Stone was exported to numerous countries but most went to Canada. Building and monumental stone exports included: Granite valued at $1.8 million, of which 52% went to Canada and 31% to Japan; dolomite valued at $1.5 million, of which 36% went to Venezuela, 32% to Canada, and 23% to Chile; marble valued at $410,000, of which 83% went to Canada; and slate valued at $279,000, of which 94% went to Canada.

Crushed stone exports included 3.4 million tons of limestone and 896,000 tons of other stone. Also, $2.4 million worth of manufactured stone was exported.

Stone was imported from many countries, but most of it came from Canada. Total stone imports were valued at $45.6

Table 33.—U.S. exports of stone
(Thousand short tons and thousand dollars)

Year	Building and monumental stone			Crushed, ground, or broken				Other manufactures of stone (value)
	Dolomite		Other (value)	Limestone		Other		
	Quantity	Value		Quantity	Value	Quantity	Value	
1973	59	652	1,244	2,316	5,400	765	4,819	948
1974	86	1,559	1,920	2,793	7,753	625	4,850	2,077
1975	49	1,464	2,449	3,386	9,993	896	5,843	2,376

million. Building and monumental stone imports included: Marble valued at $15.5 million, granite valued at $8.8 million, and other stone valued at $14.6 million. Ninety-one percent of the dressed marble came from Italy; 65% of the dressed granite came from Italy and 25% from Canada; 54% of the rough granite came from Canada and 31% from the Republic of South Africa; and 91% of the rough limestone came from the Dominican Republic.

Crushed limestone imports, mainly from Canada, were 1.6 million tons valued at $2.4 million. Imports of other crushed stone were 1.4 million tons from Canada valued at $2.8 million.

Table 34.—U.S. imports for consumption of stone and whiting, by class

Class	1974 Quantity	1974 Value (thousands)	1975 Quantity	1975 Value (thousands)
Granite:				
Monumental, paving, and building stone:				
Rough ----- cubic feet--	184,533	$1,678	243,320	$2,369
Dressed, manufactured ----- do----	370,306	4,544	327,938	5,617
Not manufactured and not suitable for monumental, paving, or building stone --short tons--	2,530	49	4,361	156
Other, n.s.p.f -----	(1)	3,027	(1)	703
Total -----	XX	9,298	XX	8,845
Marble, breccia, and onyx:				
In block, rough, or squared ----- cubic feet--	13,089	164	14,112	209
Sawed or dressed, over 2 inches thick ----do----	2,273	52	361	8
Slabs and paving tiles ----- superficial feet--	8,695,485	11,007	5,183,004	7,663
All other manufactures -----	(1)	8,121	(1)	7,601
Total -----	XX	19,344	XX	15,481
Travertine stone:				
Rough, unmanufactured ----- cubic feet--	6,846	22	4,008	19
Dressed, suitable for monumental, paving, and building stone ----- short tons--	15,029	3,036	22,548	2,994
Other, n.s.p.f -----	(1)	185	(1)	447
Total -----	XX	3,243	XX	3,460
Limestone:				
Monumental, paving, and building stone:				
Rough ----- cubic feet--	12,056	15	13,889	24
Dressed, manufactured ----- short tons--	356	37	3,863	164
Crude, not suitable for monumental, paving, or building stone ----- do------	55,486	208	147,262	579
Other, n.s.p.f -----	(1)	60	(1)	43
Total -----	XX	320	XX	810
Slate:				
Roofing ----- square feet--	1,088	1	--	--
Other, n.s.p.f -----	(1)	7,754	(1)	6,597
Total -----	XX	7,755	XX	6,597
Quartzite ----- short tons--	74,977	713	122,245	804
Stone and articles of stone n.s.p.f.:				
Statuary and sculptures -----	(1)	343	(1)	366
Stone, unmanufactured ----- short tons--	8,196	226	10,610	215
Building stone, rough ----- cubic feet--	2,023	3	6,909	11
Building stone, dressed ----- short tons--	743	59	783	63
Other -----	(1)	2,581	(1)	2,235
Total -----	XX	3,212	XX	2,890
Stone, chips, spall, crushed, or ground:				
Marble, breccia, and onyx chips ----- short tons--	4,602	123	2,522	80
Limestone, chips and spalls, crushed, or ground do----	1,787,911	2,537	1,616,312	2,432
Stone chips and spalls, and stone crushed or ground n.s.p.f ----- do----	1,733,001	2,997	1,371,363	2,764
Slate chips and spalls, and slate crushed or ground ----- do----	--	--	353	1
Total ----- do----	r 3,525,514	5,657	2,990,550	5,277
Whiting:				
Whiting, dry, ground, or bolted ----- do----	34,181	1,638	20,115	1,219
Chalk whiting precipitated ----- do----	3,345	451	1,563	242
Total ----- do----	37,526	2,089	21,678	1,461
Grand total -----	XX	51,631	XX	45,625

r Revised. XX Not applicable.
1 Quantity not reported.

WORLD REVIEW

Stone was produced in almost every country of the world. The largest quantities are produced near the points of consumption, mainly in the highly industrialized countries. World output of dimension stone in 1975 was estimated at 37 million tons. Europe provided about 75% of the total, Asia 18%, and North America 5%. The dimension stone industry is not expected to expand during the next 25 years.

World output of crushed stone in 1975 was estimated at 5.0 billion tons, of which Europe provided 39%, Asia 26%, and North America 23%. Output is expected to expand at a rate of 4% per year and reach 15 billion tons annually by the year 2000.

Canada.—Output of stone in Canada in 1974 was 94.8 million tons, of which 1.87 million tons (20%) was exported. The stone was used for road metal (41%), concrete aggregate (16%), asphalt aggregate (6%), railroad ballast (4%), and other uses (the remainder). Of the total, 86% was limestone and 9% was granite. The leading producing provinces were Quebec (51%) and Ontario (40%).

France.—Output of dimension stone was about 4 million tons. France ranked second in the world in production of dimension stone, with 11% of the total. Output of crushed stone was about 140 million tons, 3% of the world's output.

Germany, West.—West Germany ranked third in world output of stone with 190 million tons, 5% of the total.

Italy.—Italy has long ranked first in the production of dimension stone. Output was about 8 million tons, 21% of the total world production. Output of crushed stone was about 70 million tons.

Japan.—Japan ranked fourth in stone production with 164 million tons, 4% of the total world production.

United Kingdom.—Output of stone in the United Kingdom was 150 million tons, 4% of the total world output. Among the producing countries, the United Kingdom ranked fifth.

U.S.S.R.—Although stone production figures are not available, output is estimated at 500 million tons, 10% of the total world production. The U.S.S.R. ranks second behind the United States in stone production.

TECHNOLOGY

The stone industry continued to be plagued by environmental restrictions and regulations. The Environmental Protection Agency published guidelines for effluents from mining which called for zero discharge of process-generated effluents.

The Stone chapter from Bulletin 667, Mineral Facts and Problems, reviews current technology in the stone industry.

Sulfur and Pyrites

By John E. Shelton [1]

There was a marked increase in sulfur prices in 1975 compared with those in 1974. The average net shipment value f.o.b. mine/plant for Frasch and recovered elemental sulfur increased by 58% from $28.88 per long ton in 1974 to $45.63 per ton in 1975. There were corresponding increases in both export and import prices. The yearend price for Frasch sulfur was $65 per ton.

Production of sulfur in all forms in 1975 decreased 1.4% below that of 1974. For the eighth consecutive year, sulfur production continued to exceed apparent domestic consumption. Sulfur was produced by 71 companies at 185 operations in 32 States; 10 companies with 47 operations accounted for 78% of the output. Production was concentrated in Texas and Louisiana. Together, these two States accounted for 78% of the total output. Distribution of production was as follows: Frasch sulfur 64%, recovered elemental sulfur 26%, and sulfur contained in other forms 10%.

Shipments of sulfur in all forms to domestic and export markets decreased 11% below those in 1974. Frasch and elemental sulfur accounted for 89% of the total sulfur shipped in 1975. The total value of shipments f.o.b. mine/plant was $459.8 million in 1975 compared with $337.1 million in 1974, an increase of 36%. Eighty-seven percent of the shipments was for domestic consumption, and 13%, for export. Shipments of sulfur in all forms in 1975 were 11% less than the quantity produced. Producers' yearend stocks of Frasch and recovered elemental sulfur were almost 30% greater than those at yearend 1974.

The apparent domestic consumption of sulfur in all forms decreased 2% below that of 1974. Sulfur for domestic consumption was obtained mainly from domestic sources: Frasch 45%, recovered elemental 27%, and sulfur in other forms 10%. The remaining 18% was obtained by imports of Frasch and recovered elemental sulfur.

After 4 years of being a net exporter of sulfur in all forms, the United States was a net importer in 1975. Exports of sulfur in all forms decreased 49% from those of 1974. Imports of sulfur in all forms in 1975 were 12% less than those of 1974.

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[1] Supervisory physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient sulfur statistics

(Thousand long tons, sulfur content)

	1971	1972	1973	1974	1975
Production:					
Frasch	7,025	7,290	7,605	7,901	7,211
Recovered elemental	1,595	1,950	2,416	2,632	2,969
Byproduct sulfuric acid	518	546	600	654	767
Pyrites	316	283	212	162	237
Other forms [1]	126	149	88	70	75
Total	9,580	10,218	10,921	11,419	11,259
Shipments (sold or used):					
Frasch	6,738	7,613	7,438	7,898	6,077
Recovered elemental	1,582	1,927	2,451	2,547	2,902
Byproduct sulfuric acid	518	546	600	654	767
Pyrites	316	283	212	162	237
Other forms [1]	126	149	88	70	75
Total	9,280	10,518	10,789	11,331	10,058
Imports:					
Frasch (Mexico)	449	269	302	954	967
Recovered elemental (Canada)	850	868	905	1,194	930
Recovered elemental (Other)	--	1	15	2	(2)
Pyrites (Canada)	130	50	--	--	--
Total	1,429	1,188	1,222	2,150	1,897
Exports:					
Crude [3]	1,532	1,847	1,771	2,580	1,288
Refined [3]	4	5	5	21	7
Crude, recovered elemental (from the Virgin Islands)	--	--	--	62	57
Total	1,536	1,852	1,776	r 2,663	1,352
Apparent consumption: [4]					
Frasch:					
Domestic	5,202	5,761	5,662	5,297	4,782
Imports	449	269	302	954	967
Recovered elemental:					
Domestic	1,582	1,927	2,451	r 2,485	2,845
Imports	850	869	920	1,196	930
Byproduct sulfuric acid	518	546	600	654	767
Pyrites:					
Domestic	316	283	212	162	237
Imports	130	50	--	--	--
Other forms [1]	126	149	88	70	75
Total	9,173	9,854	10,235	r 10,818	10,603
Yearend producers' stocks: [5]					
Frasch	4,023	3,665	3,816	3,744	4,857
Recovered elemental	97	131	111	213	269
Total	4,120	3,796	3,927	3,957	5,126

r Revised.
1 Hydrogen sulfide and liquid sulfur dioxide.
2 Less than ½ unit.
3 Accounted for as Frasch sulfur.
4 Measured as shipments, plus imports, minus exports.
5 Reported producers' stocks after inventory adjustments.

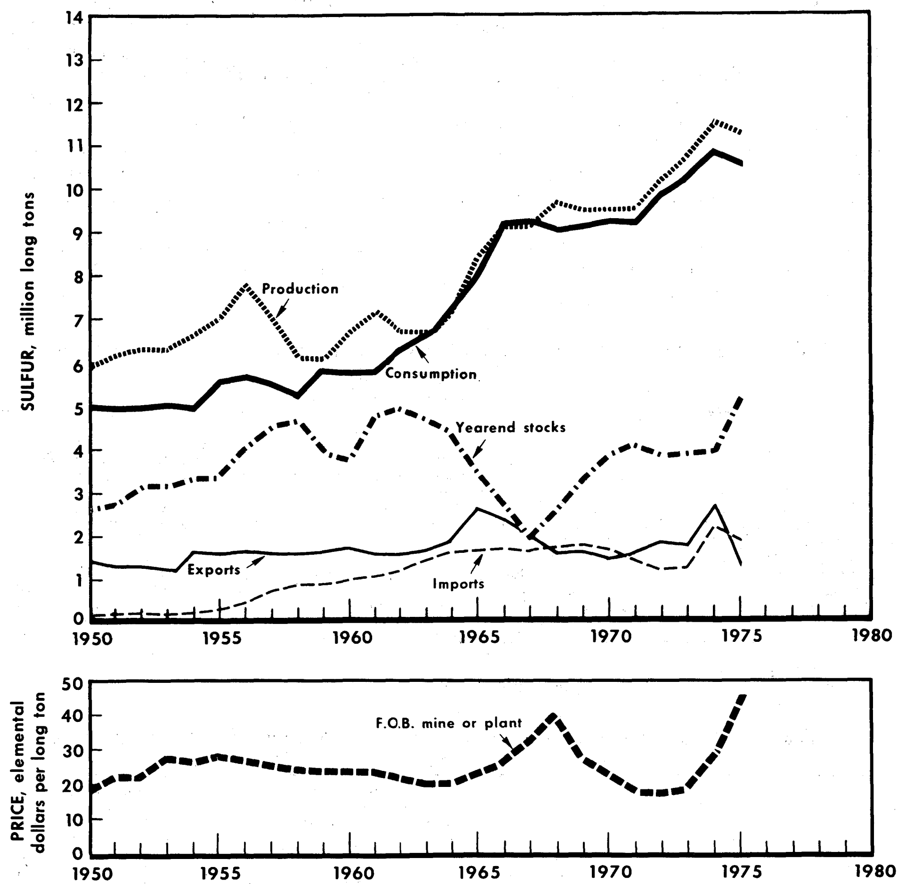

Figure 1.—Trends in the sulfur industry in the United States.

DOMESTIC PRODUCTION

Frasch Sulfur.—Output of Frasch sulfur was 64% of the domestic production of sulfur in all forms in 1975 compared with 69% in 1974.

In 1975, there were 13 Frasch mines, all in Texas and Louisiana. Producers and mines in Louisiana were Freeport Minerals Co. at Garden Island Bay, Grand Isle, Grand Ecaille, and Lake Pelto; and Texasgulf, Inc., at Bully Camp. Producers and mines in Texas were Atlantic Richfield Co. at Fort Stockton; Duval Crop. at Culberson; Jefferson Lake at Long Point Dome; and Texasgulf, Inc., at Boling Dome, Fannett Dome, Moss Bluff Dome, Spindletop Dome, and the new mine at Comanche Creek.

The 11 mines operated by Duval Corp., Freeport Minerals Co., and Texasgulf, Inc., accounted for most of the Frasch sulfur production. A relatively small portion of the output was from the other two producers operating one mine each.

Production was again concentrated at the larger low-cost mines to counteract increasing production costs. The five largest mines, with a production rate in excess of 500,000 tons per year each, accounted for 84% of the total Frasch sulfur production compared with 81% in 1974. These mines also accounted for 54% of the total output of sulfur in all forms in 1975 compared with 56% in 1974. Five mines with production over 100,000 tons accounted for

14% of the total. The remaining 2% of the Frasch output came from the other three mines.

Producers' shipments of Frasch sulfur were 23% less than in 1974. Approximately 21% of the total shipments were for export and 79% were for the domestic market compared with 33% and 67%, respectively, in 1974. Owing to a greater decrease in shipments than in production, producers' reported stocks after inventory adjustments were 30% larger than at yearend 1974.

Despite a decrease in the quantity of Frasch sulfur shipped, the total value of shipments, f.o.b. mine, increased 26% over that of 1974 to an alltime reported high of $305 million. The average unit shipping value, f.o.b. mine, was $50.16 per ton compared with the unit value of $30.52 per ton in 1974, an increase of $19.64 per ton or 64%. The yearend 1975 quoted price for Frasch sulfur was $65 per long ton ex-terminal, Tampa, Fla., an increase of 14% over the quoted price of $57 per ton at yearend 1974.

Table 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States

(Thousand long tons)

	1972		1973		1974		1975	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Frasch sulfur	7,290	7,290	7,605	7,605	7,901	7,901	7,211	7,211
Recovered elemental sulfur	1,950	1,950	2,416	2,416	2,632	2,632	2,969	2,969
Byproduct sulfuric acid (basis 100%) produced at Cu, Zn, and Pb plants	1,669	546	1,834	600	2,001	654	2,345	767
Pyrites	741	283	559	212	424	162	625	237
Other forms [1]	173	149	107	88	82	70	110	75
Total	XX	10,218	XX	10,921	XX	11,419	XX	11,259

XX Not applicable.
[1] Hydrogen sulfide and liquid sulfur dioxide.

Table 3.—Sulfur produced and shipped from Frasch mines in the United States

(Thousand long tons and thousand dollars)

Year	Production			Shipments	
	Texas	Louisiana	Total [1]	Quantity	Value [2]
1971	3,408	3,616	7,025	6,738	117,894
1972	3,755	3,534	7,290	7,613	132,385
1973	4,294	3,311	7,605	7,438	138,578
1974	4,593	3,308	7,901	7,898	241,066
1975	4,141	3,070	7,211	6,077	304,843

[1] Data may not add to totals shown because of independent rounding.
[2] F.o.b. mine.

Recovered Sulfur.—Production of recovered elemental sulfur, a nondiscretionary byproduct from natural gas and petroleum refinery operations, accounted for 26% of the total domestic production of sulfur in all forms compared with 23% in 1974. Production and shipments reached an alltime high with increases of 13% and 14%, respectively, over those of 1974, indicating the increasing importance of recovered sulfur as a source of domestic supply. This type of sulfur was produced by 56 companies at 140 plants in 28 States, 1 plant in Puerto Rico, and 1 in the Virgin Islands. Most of the plants were of relatively small size, with only five reporting an annual production exceeding 100,000 tons. The 10 largest plants accounted for 42% of the output, and the combined production from the 5 leading States was 67% of the total. By source, 55% was produced by 38 companies at 79 refineries or satellite plants treating refinery gases, and 2 coking operations, and 45% was produced by 29 companies at 59 natural gas treatment plants.

The five largest recovered elemental sulfur producers were Exxon Co., U.S.A., Getty Oil Co., Mobil Oil Corp., Shell Oil Co., and Standard Oil Co. (Indiana). Together, their 35 plants accounted for 53% of recovered elemental sulfur production in 1975.

The total value of shipments of recovered elemental sulfur in 1975 increased 73% to an alltime high of almost $105 million. The average reported shipment value, f.o.b. plant, was $36.14 per ton, compared with $23.79 per ton in 1974, an increase of 52%. There were wide variations in the reported sales prices by plants in different regions of the Nation because of local competitive factors in the regional markets served by recovered sulfur producers, including competition from Canadian sources.

The leading States in production of recovered elemental sulfur were Texas, California, Mississippi, Florida, and Alabama. Together these States contributed 67% of the total 1975 output. Production in 1975 increased compared with 1974 by 71% in Alabama, 44% in Mississippi, and 14% in Florida. The production rate in California was essentially unchanged, but it decreased by 6% in Texas. Recovery of sulfur in Alabama, Florida, and Mississippi was mainly from the treatment of dry sour natural gas and sour natural gas associated with petroleum in deep Jurassic formations. Indications were of further increases in sulfur recovery in future years.

Table 4.—Recovered sulfur produced and shipped in the United States

(Thousand long tons and thousand dollars)

Year	Production			Shipments	
	Natural gas plants	Petroleum refineries	Total [1]	Quantity	Value [2]
1971	638	957	1,595	1,582	27,483
1972	819	1,131	1,950	1,927	30,060
1973	1,046	1,370	2,416	2,451	37,873
1974	1,219	1,414	2,632	2,547	60,599
1975	1,342	[3] 1,627	2,969	2,902	104,886

[1] Data may not add to totals shown because of independent rounding.
[2] F.o.b. plant.
[3] Includes a small quantity from coking operations.

Table 5.—Recovered sulfur produced and shipped in the United States, by State

(Thousand long tons and thousand dollars)

State	1974			1975		
	Production	Shipments		Production	Shipments	
	Quantity	Quantity	Value	Quantity	Quantity	Value
Alabama	120	116	3,503	205	206	8,025
Arkansas	25	25	553	18	18	677
California	394	382	4,716	395	375	6,949
Florida	250	249	W	285	285	W
Illinois and Indiana	181	181	5,678	203	199	6,792
Kansas	9	9	218	10	10	291
Louisiana	70	69	1,938	90	91	4,311
Michigan and Minnesota	49	48	1,197	55	55	1,977
Mississippi	217	141	3,780	312	298	13,425
New Jersey	71	70	2,255	83	83	3,709
New Mexico	34	35	942	28	27	974
New York	3	3	W	W	W	W
Ohio	10	10	292	15	15	640
Oklahoma	W	W	W	8	8	239
Pennsylvania	26	26	639	68	68	2,551
Texas	856	861	19,746	801	796	29,072
Wisconsin	2	2	24	1	1	10
Wyoming	55	52	W	52	39	W
Other States [1]	261	269	15,118	339	327	25,246
Total [2]	2,632	2,547	60,599	2,969	2,902	104,886

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Combined to avoid disclosing individual company confidential data; includes Colorado, Delaware, Missouri, Montana, New York (1975), North Dakota, Oklahoma (1974), Utah, Virginia, Washington, Virgin Islands, and Puerto Rico (1975).
[2] Data may not add to totals shown because of independent rounding.

Byproduct Sulfuric Acid.—Sulfur contained in byproduct sulfuric acid produced at copper, lead, and zinc smelters and roasters during 1975 was 7% of the total domestic production of sulfur in all forms compared with 6% in 1974. The total output and value reached alltime highs in 1975. In 1975, output was 17% higher and total value was 46% higher than in 1974. Byproduct sulfuric acid was produced by 12 companies at 22 plants in 13 States. Twelve acid plants operated in conjunction with copper smelters, and 10 plants were accessories to lead and zinc roasting and smelting operations. The five largest acid plants accounted for 47% of the output, and production in five States was 78% of the total. The five largest producers of byproduct sulfuric acid were American Smelting and Refining Co., Magma Copper Co., Kennecott Copper Corp., Phelps Dodge Corp., and St. Joe Minerals Corp., whose 13 plants produced 68% of the byproduct sulfuric acid in 1975.

Table 6.—Byproduct sulfuric acid[1] (sulfur content) produced in the United States
(Thousand long tons and thousand dollars)

Year	Copper plants[2]	Lead and zinc plants[3]	Total	Value
1971	234	284	518	21,293
1972	295	251	546	22,897
1973	318	282	600	24,175
1974	373	281	654	29,370
1975	521	246	767	42,956

[1] Includes acid from foreign materials.
[2] Excludes acid from pyrites concentrates.
[3] Excludes acid made from native sulfur.

Pyrites, Hydrogen Sulfide, and Sulfur Dioxide.—Contained sulfur in pyrites, hydrogen sulfilde, and sulfur dioxide represented 3% of the total production of sulfur in all forms in 1975, compared with 2% in 1974. The total sulfur content in these products was 34% more than that of 1974, and the value of shipments was 17% higher. Pyrites was produced by three companies at three mines in three States; hydrogen sulfide by four companies at five plants in four States; and sulfur dioxide by two companies at two plants in two States. The three largest producers of these products were Cities Service Co. (pyrites, hydrogen sulfide, and sulfur dioxide); Phillips Petroleum Co. (hydrogen sulfide); and Shell Oil Co. (hydrogen sulfide). These companies combined, at one mine and five plants, accounted for 95% of the contained sulfur produced in the form of these products.

Table 7.—Pyrites, hydrogen sulfide, and sulfur dioxide sold or used in the United States, sulfur content
(Thousand long tons and thousand dollars)

Year	Pyrites	Hydrogen sulfide and sulfur dioxide	Total	Value
1971	316	126	442	9,530
1972	283	149	432	9,227
1973	212	88	300	7,188
1974	162	70	232	6,052
1975	237	75	312	7,097

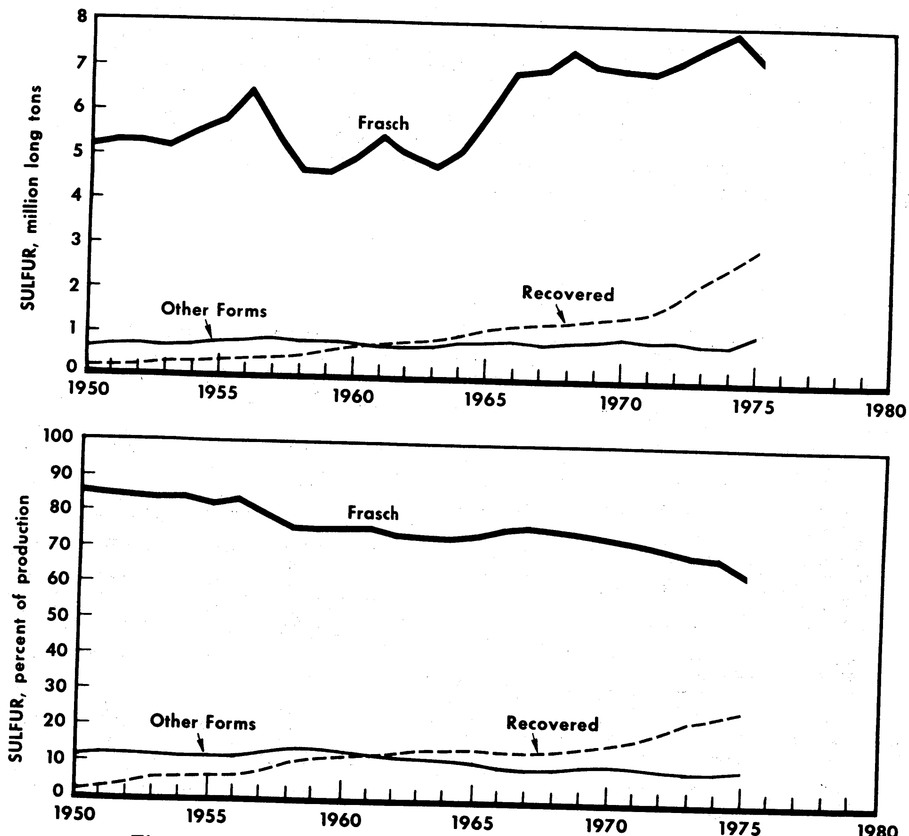

Figure 2.—Trends in the production of sulfur in the United States.

CONSUMPTION

In 1975, apparent domestic consumption of sulfur in all forms was 10.6 million tons, 2% below the alltime high in 1974. Eighty-two percent of this consumption was from domestic sources compared with 80% in 1974. The supply sources were domestic Frasch sulfur, 45% compared with 49% in 1974; domestic recovered elemental sulfur, 27% compared with 23% in 1974; and combined domestic byproduct sulfuric acid, pyrites, hydrogen sulfide, and sulfur dioxide, 10% compared with 8% in 1974. The remaining 18% of the sulfur was from imports of Frasch and recovered elemental sulfur compared with 20% in 1974.

The apparent sales of domestic Frasch sulfur to domestic consumers decreased by 515,000 tons, or 10% below shipments in 1974. Apparent shipments of recovered elemental sulfur for domestic consumption increased by 360,000 tons, or 14% over those in 1974. The reported sales of byproduct sulfuric acid, pyrites, hydrogen sulfide, and sulfur dioxide increased 193,000 tons or 22% above those in 1974. Total supplies of domestic sulfur in all forms to the domestic market increased by 38,000 tons. Total imports of Frasch and recovered elemental sulfur decreased 253,000 tons or 12% below those of 1974. Imports of Frasch sulfur increased 13,000 tons, while imports of recovered elemental sulfur from Canada decreased 264,000 tons and from other countries by almost 2,000 tons.

Approximately 90% of all sulfur consumed was converted to sulfuric acid prior to final end use. The manufacture of fertilizers accounted for about 56% of all domestic sulfur consumption. Plastics, synthetic products, paper products, paints, nonferrous metals production, and explosives accounted for about 21% of domestic demand. The remaining uses were widespread, as most products require sulfur in one form or another during some stage of their manufacture. By region, the distribution of sulfur consumption was as follows: Southern States, except Florida, 42%; Florida, 28%; North-Central States, 11%; Western States, 11%; and Northeastern States, 8%.

Table 8.—Apparent consumption of sulfur in the United States [1]

(Thousand long tons)

	1971	1972	1973	1974	1975
Frasch:					
Shipments	6,738	7,613	7,438	7,898	6,077
Imports	449	269	302	954	967
Exports	1,536	1,852	1,776	2,601	1,295
Total	5,651	6,030	5,964	6,251	5,749
Recovered:					
Shipments	1,582	1,927	2,451	2,547	2,902
Imports	850	869	920	1,196	930
Exports from the Virgin Islands	--	--	--	62	57
Total	2,432	2,796	3,371	r 3,681	3,775
Pyrites:					
Shipments	316	283	212	162	237
Imports [e]	130	50	--	--	--
Total	446	333	212	162	237
Byproduct sulfuric acid	518	546	600	654	767
Other forms [2]	126	149	88	70	75
Total all forms	9,173	9,854	10,235	r 10,818	10,603

[e] Estimate. [r] Revised.

[1] Crude sulfur or sulfur content.

[2] Includes consumption of hydrogen sulfide and liquid sulfur dioxide.

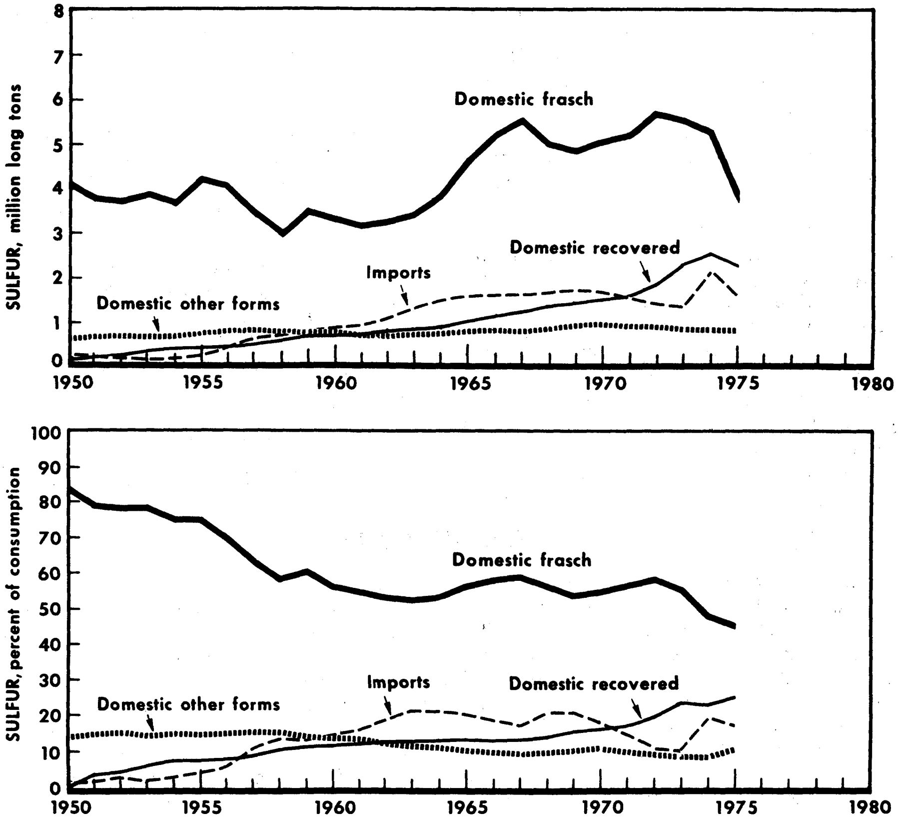

Figure 3.—Trends in consumption of sulfur in the United States.

STOCKS

Producers' stocks of Frasch plus recovered elemental sulfur, after inventory adjustments, increased 30% over the inventory at yearend 1974. Frasch sulfur stocks increased 30% and recovered elemental sulfur stocks increased 26%. The combined yearend stocks amounted to an approximated 6.9-month supply based on 1975 domestic and export demands for domestically produced Frasch and recovered elemental sulfur.

Table 9.—Producers' yearend stocks
(Thousand long tons)

Year	Frasch	Recovered	Total
1971	4,023	97	4,120
1972	3,665	131	3,796
1973	3,816	111	3,927
1974	3,744	213	3,957
1975	4,857	269	5,126

PRICES

The quoted price for liquid sulfur ex-terminal Tampa, Fla., rose from $57 per long ton at yearend 1974 to $65 per ton at yearend 1975, an increase of 14%. There were similar price increases in other markets.

On the basis of shipments and total value reported to the Bureau of Mines, the average value of shipments of Frasch sulfur f.o.b. mine for both domestic consumption and exports during 1975 rose to $50.16 per ton, compared with $30.52 per ton in 1974, an increase of 64%.

The recovered elemental sulfur industry was in a less favorable position to obtain full benefit of the higher sulfur prices as this market was subject to regional competitive forces. As a nondiscretionary byproduct there was a general tendency to sell sulfur in local markets. Sales also were more dependent upon the industrial sector of the market. Shipment values varied widely in different regions; lowest in the West, somewhat higher in the midcontinent, and near the values for Frasch sulfur in the East and South. Overall, the reported unit shipment values, f.o.b. plant, in 1975 were $36.14 per ton, up 52% from $23.79 per ton in 1974.

Marketing sulfur produced in other than the elemental form reflected competitive positions in the limited regional markets for these products. In 1975, shipments of sulfur contained in byproduct sulfuric acid increased $11.09 per ton of contained sulfur or 25%, whereas the unit value for sulfur contained in pyrites, hydrogen sulfide, and sulfur dioxide decreased $3.34 or 13% compared with that of 1974.

Table 10.—Reported sales values of shipments of elemental sulfur, f.o.b. mine or plant
(Dollars per long ton)

Year	Frasch	Recovered	Total
1971	17.50	17.37	17.47
1972	17.39	15.60	17.03
1973	18.63	15.45	17.84
1974	30.52	23.79	28.88
1975	50.16	36.14	45.63

FOREIGN TRADE

The United States was a net importer of sulfur in 1975, for the first time since 1970. Imports, in the form of elemental sulfur, decreased 12% to 1.9 million tons. Exports, almost entirely in the form of Frasch sulfur, were down 49% to 1.35 million tons. As a result of the large decrease in exports, the net import balance in 1975 was 545,000 tons compared with a net export of 513,000 tons in 1974.

Exports from the United States were almost entirely in the form of Frasch sulfur. The tonnage of crude sulfur exported in 1975 was 50% less than that in 1974, and exports of refined sulfur declined 67%. The total value of exports declined 26% below that of 1974. The reported average export value was $55.44 per ton in 1975 compared with $37.43 in 1974, an increase of 48%. Belgium-Luxembourg and the Netherlands received 63% of the exports, mainly for transshipment to other European Community Countries. Brazil was the third largest customer, receiving 14% of the exports. Not included in the aforementioned were exports from the Virgin Islands, which were 62,000 tons valued at $1.9 million in 1974 and 57,000 tons valued at almost $3.2 million in 1975.

While imports of sulfur decreased 12%, total value increased 39% and the average value increased 57% from $23.78 per ton in 1974 to $37.35. Imports of sulfur consisted largely of recovered elemental sulfur from Canada and Frasch sulfur from Mexico. In 1975, imports of Frash sulfur from Mexico increased 1%, continuing the penetration of the U.S. market started in 1974, but the value increased 63%. Imports of recovered elemental sulfur mostly from Canada declined 22%, however, the value was up 3%. Despite the overall decrease in imports of sulfur, the total value increased 39%, reflecting higher prices for sulfur in the world market.

Table 11.—U.S. exports of sulfur
(Thousand long tons and thousand dollars)

Year	Crude		Refined	
	Quantity	Value	Quantity	Value
1971	1,532	27,844	4	1,019
1972	1,847	32,409	5	1,278
1973	1,771	34,330	5	1,461
1974 [1]	2,580	95,516	21	1,829
1975 [1]	1,288	69,553	7	2,248

[1] Excludes exports from the Virgin Islands to foreign countries 1974: 61,556 long tons ($1,891,142); 1975: 56,632 long tons ($3,172,094); see table 13.

Table 12.—U.S. exports of crude sulfur, by country
(Thousand long tons and thousand dollars)

Destination	1974		1975	
	Quantity	Value	Quantity	Value
Algeria	--	--	11	770
Argentina	63	2,403	26	1,557
Australia	176	5,722	--	--
Belgium-Luxembourg	878	35,516	449	23,589
Brazil	332	12,107	186	11,475
Canada	50	1,465	48	1,234
Chile	46	1,937	(1)	1
Colombia	5	272	1	28
Finland	10	339	--	--
France	11	322	16	600
Germany, West	20	802	(1)	7
Greece	14	842	35	2,017
India	11	441	--	--
Ireland	(1)	5	--	--
Israel	15	473	45	2,578
Italy	136	4,891	43	2,459
Jamaica	1	67	1	50
Korea, Republic of	8	675	--	--
Mexico	4	104	1	37
Morocco	20	1,080	--	--
Netherlands	521	14,914	358	19,663
New Zealand	33	1,038	42	1,850
Peru	(1)	(1)	3	183
Senegal	7	427	--	--
South Africa, Republic of	r 59	r 3,576	(1)	2
Spain	14	579	--	--
Thailand	--	--	11	670
Tunisia	114	3,947	--	--
United Kingdom	3	96	2	110
Uruguay	18	666	10	641
Zaire	6	474	--	--
Other	5	336	(1)	32
Total [2]	2,580	95,516	1,288	69,553

r Revised.
[1] Less than ½ unit.
[2] Excludes exports from the Virgin Islands to foreign countries 1974: 61,556 long tons ($1,891,142); 1975: 56,632 long tons ($3,172,094); see table 13.

Table 13.—Sulfur exported from the Virgin Islands to foreign countries
(Thousand long tons and thousand dollars)

Country	1974		1975	
	Quantity	Value	Quantity	Value
Argentina	--	--	10	558
Brazil	20	809	13	774
Chile	10	417	--	--
France	--	--	11	489
Italy	19	371	9	518
Jamaica	3	45	3	192
South Africa, Republic of	--	--	11	641
United Kingdom	10	249	--	--
Total	62	1,891	57	3,172

Table 14.—U.S. imports of sulfur [1]
(Thousand long tons and thousand dollars)

Year	Elemental		Pyrites [2]	
	Quantity	Value	Quantity e	Value
1971	1,299	25,419	130	NA
1972	1,138	16,288	50	NA
1973	1,222	14,871	--	--
1974	2,150	51,124	--	--
1975	1,897	70,848	--	--

e Estimate. NA Not available.
[1] Crude sulfur or sulfur content.
[2] From Canada.

Table 15.—U.S. imports of elemental sulfur, by country
(Thousand long tons and thousand dollars)

Country	1974		1975	
	Quantity	Value	Quantity	Value
Canada	1,194	20,692	930	21,398
France	(1)	4	--	--
Germany, West	(1)	105	(1)	33
Guyana	1	4	--	--
Mexico	954	30,298	967	49,417
United Kingdom	1	21	--	--
Total	2,150	51,124	1,897	70,848

[1] Less than ½ unit.

WORLD REVIEW

Owing to reduced phosphate fertilizer production and lower usage of sulfur for industrial consumption, demand for sulfur was down. With the weakening of demand, prices for sulfur at yearend 1975 receded from the alltime high in 1974.

World production of sulfur decreased slightly in 1975. Following the pattern of the past several years, production of sulfur in all forms continued to exceed demand. As a result, producers' stocks increased by an estimated 5.5 million tons. Most of the stock increase occurred in Canada where stocks increased 2.5 million tons.[2]

Canada.—Production of sulfur in all forms totaled 7.43 million tons. Recovered elemental sulfur produced at sour natural gas plants, refineries, and tar-sand operations represented 91% of the output. Sulfur contained in byproduct sulfuric acid produced at nonferrous metal smelters accounted for essentially all of the remaining 9% since there was a negligible production of pyrites in 1975.

In 1975, 45 sour-gas plants, 2 in British Columbia, 1 in Saskatchewan, and the remainder in Alberta, were operating with a combined annual capacity of 9 million tons of sulfur. Production from smelter gases was 696,000 tons of contained sulfur in sulfuric acid, an increase of 12% despite reduced base metal output It is expected that smelter gases will continue to increase in importance as a source of sulfuric acid in Canada.[3]

The Province of Alberta accounted for 86% of the Canadian output, with all the production in the form of recovered elemental sulfur. Essentially all production of sulfur was from plants treating sour natural gas and a small fraction was from tar-sand operations. Alberta's production declined 5% to 6.4 million tons in 1975. Shipments of sulfur decreased from 4.9 million tons in 1974 to 3.8 million tons in 1975. Of these shipments, 2.2 million tons was to offshore foreign markets other than the United States, down from 3.0 million tons in 1974. Producers' stocks rose to 16.1 million tons at yearend 1975 from 13.5 million tons at yearend 1974.

The value of marketed sulfur, f.o.b. plant, was $19.24 in December 1975 up from $18.52 in December 1974.[4]

Cyprus.—Production of pyrite and cupreous pyrite was down to 178,000 tons in 1974 from a peak of 1.098 million tons in 1960. According to Sulphur magazine, in 1960 exports of pyrite represented 20% of the total export value of Cyprus but had dropped to 7.5% by 1973 when production was 470,000 tons and exports were 322,000 tons.[5]

France.—Production of sulfuric acid declined about 20% paralleling the decline in demand for sulfuric acid for production of phosphatic fertilizers.[6]

Reserves of sour natural gas near the village of Lacq were estimated at 8,125 million cubic feet with a total recoverable sulfur content estimated at 50 million tons.[7]

Iraq.—The sulfur deposits of the Mishraq area have an estimated resource of

[2] Sulphur (London). Western World Brimstone 1975. No. 122, January–February 1976, pp. 5–8.
[3] Pearse, G. H. K. Sulphur. Canadian Mineral Survey, 1975. February 1976, pp. 69–70.
[4] Energy Resources Conservation Board, Province of Alberta, Canada. Summary of Monthly Statistics. Alberta Energy Resource Industries. December 1975, p. 10.
[5] Spooner, E. T. C. Cyprus Pyrite Today. Sulphur (London), No. 121, November–December 1975, pp. 23–27.
[6] Sulphur (London). World Markets. No. 122, January–February 1976, p. 9.
[7] Sulphur (London). SNPA's Lacq Complex. No. 122, January–February 1976, pp. 35–40.

200 million tons of sulfur. The hydrodynamic mining process used at this deposit, results in problems associated with the movement of injected water such as pollution of the River Tigris, loss of heating water, and subsidence. A study of the geohydrology of the area may help to minimize some problems.[8]

Japan.—There were indications that the demand for sulfuric acid was picking up during the last half of 1975. Because of the general downturn in the economy particularly for titanium dioxide and fibers, the demand for sulfur had declined. Production of sulfuric acid was curtailed as stocks reached a postwar high of 199,000 tons in January.

Mexico.—Production of Frasch sulfur decreased from 2.3 million tons in 1974 to 2.1 million tons in 1975. Total exports declined 25% to 1.4 million tons in 1975. This decline in markets was essentially in Western Europe and Asia whereas exports to the United States were essentially unchanged at 1.0 million tons.

Poland.—Total exports of Polish sulfur were slightly higher in 1975 than in 1974. Exports to market economy countries and the U.S.S.R. were about the same, whereas shipments to the rest of the world declined 23% from 1974.

Spain.—According to Sulphur magazine national economic development plans expect production of pyrite to increase from the current annual production of about 2.5 million tons per year to 4 million tons per year by 1980. In addition to production of sulfuric acid and iron cinder, it is expected that copper, lead, zinc, gold, and silver will be recovered as byproducts.[9]

U.S.S.R.—Production of sulfuric acid in the U.S.S.R. increased 12% to 18.3 million tons in 1975. Production of sulfur will be increased at the Orenburg gasfield. Construction of the third phase of the Orenburg complex will be built by the U.S.S.R. with engineering by the French engineering group, Technip, and will utilize technology by Société Nationale des Pétroles d'Aquitaine (SNPA).[10]

[8] Featherstone, R. E., and A. M. Samarrie. Geohydrology of Mishraq. Sulphur (London), September–October 1975, pp. 44–49.
[9] Strauss, G. K., and J. Madel. Thorsis Sulphur and Copper Co. Ltd.—From Sulphur Ore to Base Metals. Sulphur (London), No. 120, September–October 1975, pp. 24–33.
[10] Sulphur (London). New Plants and Projects. No. 121, November–December 1975, p. 16.

Table 16.—Sulfur: World production in all forms by type
(Thousand long tons)

Country [1] and type	1973	1974	1975 p
Algeria:			
Content of pyrite	5	e 5	e 5
Byproduct from petroleum and natural gas e	20	20	20
Total	25	25	25
Argentina:			
Native, other than Frasch	35	25	27
Byproduct from all sources	24	24	20
Total	59	49	47
Australia:			
Content of pyrite	115	106	e 106
Byproduct:			
From metallurgy	r 316	298	e 315
From petroleum e	42	45	41
Total	r 473	449	e 462
Austria:			
Byproduct:			
From metallurgy	8	7	8
From petroleum and natural gas	16	15	17
From spent oxide	1	1	--
From gypsum	16	26	28
Total	41	49	53

See footnotes at end of table.

Table 16.—Sulfur: World production in all forms by type—Continued

(Thousand long tons)

Country [1] and type	1973	1974	1975 [p]
Belgium; byproduct:			
Elemental	30	26	24
Other forms	r 202	194	169
Total	r 232	220	193
Bolivia; native, other than Frasch [2]	r 55	41	22
Brazil; byproduct from petroleum [3]	2	r e 1	e 1
Bulgaria:			
Content of pyrite [e]	63	64	64
Byproduct from all sources [e]	r 114	r 118	122
Total	r 177	182	186
Canada:			
Content of pyrite	11	24	9
Byproduct:			
From metallurgy	675	623	696
From natural gas	7,067	6,840	6,469
From petroleum	150	160	170
From tar sands	95	95	84
Total	7,998	7,742	7,428
Chile: [4]			
Native, other than Frasch:			
Refined	8	7	5
Caliche	22	24	16
Byproduct from metallurgy [5]	16	23	26
Total	46	54	47
China, People's Republic of:			
Native, other than Frasch [e]	130	130	130
Content of pyrite [e]	900	900	900
Byproduct, all sources [e]	120	120	120
Total [e]	1,150	1,150	1,150
Colombia:			
Native, other than Frasch	27	30	31
Byproduct, all sources [e]	3	3	10
Total	30	33	41
Cuba; content of pyrite [e]	20	20	20
Cyprus; content of pyrite [6]	r 219	85	96
Czechoslovakia: [4]			
Native, other than Frasch	5	e 5	e 5
Content of pyrite [e]	r 118	r 118	122
Total	r 123	123	127
Denmark; byproduct from all sources	7	5	8
Ecuador:			
Native, other than Frasch	--	--	(7)
Byproduct from petroleum and natural gas [e]	1	1	1
Total	1	1	1
Egypt; byproduct from petroleum [3]	e 1	3	e 3
Finland:			
Native, other than Frasch	121	98	e 100
Content of pyrite	r 351	335	e 335
Byproduct:			
From metallurgy:			
Lead, copper, zinc sulfide	125	r e 128	e 128
Other	237	243	246
From petroleum	9	9	57
Total	r 843	813	866
France; byproduct:			
From natural gas	1,725	1,810	1,734
From petroleum	56	68	e 65
From unspecified sources	45	38	92
Total	1,826	1,916	1,891

See footnotes at end of table.

Table 16.—Sulfur: World production in all forms by type—Continued

(Thousand long tons)

Country [1] and type	1973	1974	1975 [p]
Germany, East: [8]			
Content of pyrite [e]	57	57	57
Byproduct from petroleum	[r] 88	88	[e] 89
Total	[r] 145	145	146
Germany, West:			
Content of pyrite	189	211	[e] 212
Byproduct:			
From metallurgy	53	47	
From petroleum and natural gas	[r] 269	405	513 (from metallurgy, petroleum and natural gas, and unspecified sources combined)
From unspecified sources	[r] 27	28	
Total	[r] 538	691	725
Greece; content of pyrite	[r] 85	88	49
Hungary:			
Content of pyrite [e]	3	3	3
Byproduct, all sources	9	9	[e] 10
Total	12	12	13
India:			
Content of pyrite	15	13	[e] 19
Byproduct:			
From metallurgy	113 (metallurgy and petroleum combined)	139 (metallurgy and petroleum combined)	138
From petroleum			6
Total	128	152	163
Indonesia; native, other than Frasch [6]	2	2	4
Iran:			
Native, other than Frasch	21	[e] 20	[e] 20
Byproduct:			
From natural gas	555	595 (natural gas and petroleum combined)	479 (natural gas and petroleum combined)
From petroleum	31		
Total	607	615	599
Iraq:			
Native, Frasch	388	600	640
Byproduct from petroleum and natural gas [e]	138	138	138
Total	526	738	778
Ireland:			
Content of pyrite	31	27	[e] 32
Byproduct from all sources	([7])	([7])	([7])
Total	31	27	32
Israel; byproduct from petroleum and natural gas [e]	10	10	18
Italy:			
Native, other than Frasch	79	60	[e] 42
Content of pyrite	[r] 766	466	492
Byproduct:			
From metallurgy [e]	[r] 49	[r] 49	49
From spent oxide [e]	30	30	30
From other sources [e]	25	25	10
From gypsum [e]	[r] 202	[r] 202	202
Total	[r] 1,151	832	825
Japan:			
Native, other than Frasch [e]	16	16	16
Content of pyrite	560	389	530
Byproduct from all sources	2,147	2,359	1,836
Total	2,723	2,764	2,382
Korea, North; content of pyrite [e] [8]	195	195	195
Korea, Republic of; content of pyrite [6]	([7])	([7])	([7])
Kuwait; byproduct from petroleum and natural gas	54	56	54
Mexico: [8]			
Native, Frasch	1,583	2,286	2,130
Byproduct, all sources	63	63	89
Total	1,646	2,349	2,219
Morocco; content of pyrite	132	155	62

See footnotes at end of table.

Table 16.—Sulfur: World production in all forms by type—Continued
(Thousand long tons)

Country [1] and type	1973	1974	1975 p
Netherlands; byproduct:			
From metallurgy	53	53	24
From petroleum			31
Total	53	54	55
Netherlands Antilles; byproduct from petroleum	80	114	86
Norway:			
Content of pyrite	358	309	e 215
Byproduct:			
From metallurgy	21	r e 21	e 21
From petroleum	6	e 6	e 3
Total	r 385	336	239
Pakistan; native, other than Frasch [4]	r 2	2	1
Peru; byproduct from all sources	16	e 16	e 16
Philippines; content of pyrite	93	75	e 74
Poland:			
Native:			
Frasch	2,928	3,659	4,273
Other than Frasch	561	369	425
Byproduct:			
From metallurgy	235	258	258
From petroleum	17	18	18
Total	3,741	4,304	4,974
Portugal:			
Content of pyrite	231	221	199
Byproduct:			
From metallurgy	42	2	--
From petroleum	3	1	8
Total	r 276	224	207
Rhodesia, Southern; content of pyrite e	30	30	30
Romania:			
Content of pyrite e	r 369	r 369	369
Byproduct, all sources e	6	6	6
Total e	r 375	375	375
Saudi Arabia; byproduct from petroleum e	5	5	18
Singapore; byproduct from petroleum e	6	6	6
South Africa, Republic of:			
Content of pyrite	217	225	256
Byproduct:			
From metallurgy	88	103	51
From petroleum			42
Total	305	328	349
South West Africa, Territory of; content of pyrite	5	4	4
Spain:			
Content of pyrite	r 1,096	1,287	1,289
Byproduct:			
From metallurgy	108	r e 108	e 108
From petroleum	2	e 2	e 2
From lignite gasification	1	e 1	e 1
Total	r 1,207	1,398	1,400
Sweden:			
Content of pyrite	228	215	208
Byproduct:			
From metallurgy	137	r e 138	e 138
From other sources	8	r e 10	e 10
Total	r 373	363	356
Switzerland; byproduct from all sources e	2	2	2
Syria; byproduct from petroleum and natural gas e	8	8	8
Taiwan:			
Native, other than Frasch	6	3	5
Content of pyrite	4	4	5
Byproduct from all sources	2	2	2
Total	12	9	12
Thailand; byproduct from all sources e	1	1	1
Trinidad and Tobago; byproduct from petroleum	r 41	28	59

See footnotes at end of table.

Table 16.—Sulfur: World production in all forms by type—Continued

(Thousand long tons)

Country [1] and type	1973	1974	1975 [p]
Turkey:			
Native, other than Frasch	17	10	[e] 17
Content of pyrite	20	35	[e] 35
Byproduct from all sources	29	[e] 29	[e] 29
Total	66	74	81
U.S.S.R.:			
Native, other than Frasch [e]	2,260	2,360	2,460
Content of pyrite [e]	[r] 3,440	[r] 3,540	3,640
Byproduct, all sources [e]	1,820	1,870	1,970
Total	[r] 7,520	7,770	8,070
United Kingdom:			
Byproduct:			
From metallurgy	57	58	[e] 60
From spent oxides	[r] 13	4	[e] 4
From unspecified sources	[r] 39	64	[e] 65
From gypsum	80	72	[e] 72
Total	[r] 189	198	201
United States:			
Native, Frasch	7,605	7,901	7,211
Content of pyrite	212	162	237
Byproduct:			
From metallurgy	600	654	767
From natural gas	1,039	1,211	2,969
From petroleum	1,377	1,421	
Other [9]	88	70	75
Total	10,921	11,419	11,259
Uruguay; byproduct from petroleum	(7)	(7)	2
Venezuela; byproduct from petroleum and natural gas	79	106	81
Yugoslavia:			
Content of pyrite	90	105	143
Byproduct:			
From metallurgy	[r] 113	83	90
From petroleum	5	4	4
Total	[r] 208	192	237
Zaire; byproduct from metallurgy	50	[e] 50	[e] 50
Zambia:			
Content of pyrite	30	29	[e] 30
Byproduct from all sources	45	[e] 50	[e] 50
Total	75	79	80
Grand total	47,437	49,362	49,164
Of which:			
Native:			
Frasch	12,504	14,446	14,254
Other	3,367	3,202	3,326
Content of pyrite	10,258	9,871	10,042
Byproduct:			
From coal gasification	1	1	1
From metallurgy	2,842	2,790	3,173
From natural gas	10,386	9,861	8,203
From petroleum	1,921	1,979	711
From tar sands	95	95	84
From petroleum and natural gas, undifferentiated	595	1,354	3,785
From spent oxides	44	35	34
From unspecified sources	5,126	5,428	5,249
From gypsum	298	300	302

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] In addition to the countries listed, a number of nations refining oil and processing nonferrous metals may produce sulfur, but such output is regarded as small and is largely, if not entirely, consumed by the producer.

[2] Exports, regarded as virtually equivalent to production, owing to minimal domestic consumption levels.

[3] May also produce sulfur from metallurgical operations and/or natural gas, but output is not reported quantitatively and no reliable basis is available for formulation of output level estimates.

[4] May also produce sulfur from natural gas and/or petroleum, but output is not reported quantitatively and no reliable basis is available for formulation of output level estimates.

[5] Includes a small output from byproduct pyrite.

[6] May also produce sulfur from petroleum refining, but output is not reported quantitatively and no reliable basis is available for formulation of output level estimates.

[7] Less than ½ unit.

[8] May also produce sulfur from metallurgical operations, but output is not reported quantitatively and no reliable basis is available for formulation of output level estimates.

[9] Sulfur content of H_2S gas and liquid SO_2 not included elsewhere.

Table 17.—World production of pyrites, by country
(Gross weight, thousand long tons)

Country [1]	1973	1974	1975 p
North America:			
Canada	23	44	19
Cuba e	50	50	50
United States [2]	559	424	625
Europe:			
Bulgaria e	150	150	150
Czechoslovakia	285	291	e 295
Finland	r 777	710	e 710
Germany, East e	140	140	140
Germany, West	421	470	e 470
Greece	r 127	184	109
Hungary e	7	7	7
Ireland	66	56	69
Italy	r 1,163	1,150	946
Norway	r 776	654	466
Portugal	524	503	455
Romania e	860	867	867
Spain	r 2,330	2,782	2,785
Sweden	443	418	407
U.S.S.R. e	r 7,300	r 7,600	7,800
Yugoslavia	213	251	341
Africa:			
Algeria	12	e 12	e 12
Morocco	401	501	201
Rhodesia, Southern e	72	74	74
South Africa, Republic of	542	562	640
South-West Africa, Territory of	12	9	9
Zambia	74	70	e 70
Asia:			
China, People's Republic of e	2,000	2,000	2,000
Cyprus	r 495	192	e 300
India	41	35	50
Japan	1,255	1,095	1,078
Korea, North e	500	500	500
Korea, Republic of	1	2	2
Philippines	200	162	159
Taiwan	11	10	14
Turkey	43	75	e 75
Oceania: Australia	241	221	e 224
Total	r 22,114	22,271	22,119

e Estimate. r Revised. p Preliminary.
[1] In addition to the countries listed, Chile produces a small quantity of byproduct pyrite, but data are incomplete to estimate gross pyrite production.
[2] Sold or used by producers.
[3] Exports.

TECHNOLOGY

The hydrodynamic method of sulfur recovery was developed to treat the Polish sulfur deposits, which were widely dispersed, relatively thin bedded, and frequently underlain by pervious strata that were not amenable to successful application of the Frasch process.[11]

Research in the quenching of liquid sulfur to reduce problems of dusting, water retention, and loading, and to facilitate storage and later transport was discussed.[12]

A stack gas cleanup process that removes particulates prior to removal of SO_2 resulted in a discharge containing 44 parts per million sulfur dioxide and 0.004 gram per standard cubic foot particulates. The SO_2 was absorbed by dilute sulfuric acid, was converted to sulfuric acid in the presence of a dissolved ferric sulfate catalyst, and was finally neutralized with limestone. The resulting gypsum is of high enough quality for use in Japan's building industry.[13]

A double alkali wet scrubbing system using sodium and calcium hydroxides has been found effective in removing SO_2 from flue gases.[14]

[11] Zakiewicz. B. Exploitation of Bedded Sulfur Deposits by the Hydrodynamic Method. Sulphur (London), No. 120, September–October 1975, pp. 35–43.

[12] Potts, H. L. Forming, Handling, and Transport of Canadian Sulfur. Sulphur (London), No. 118, May–June 1975, pp. 34–39.

[13] Sulphur (London). Stack Gas Clean-up Process Helps Solve Material Problem in Japan. No. 121, November–December 1975, pp. 39–41.

[14] Gall. R. L., and E. J. Piasecki. The Double Alkali Wet Scrubbing System. Chem. Eng. Process, v. 71, No. 5, May 1975, pp. 72–76.

Chemical Week. Two-step Method to Stack-Gas Cleanup. V. 118, No. 4, Jan. 28, 1976, p. 29.

A molten salt bath of lithium, sodium, potassium, and calcium carbonates has been used to remove sulfur and particulates from low-Btu gas made from coal. The process saves energy in that the gas is passed through the molten bath at 700° C rather than cooling the gas to room temperature for hydrogen sulfide removal and reheating for combustion. The process removed 98% of the sulfur but was only half as efficient in particulate removal and picked up too much of the alkali metals.[15]

The types and construction of tall stacks were discussed.[16] Tall stacks have been built since the early 1800's. A typical chimney for a 1,000-megavolt fossil fuel generating station would be 800 feet tall. The tallest stack in the world is 1,250 feet 9 inches at International Nickel Co.'s Copper Cliff smelter, Sudbury, Ontario.

Sulfur dioxide discharged in the atmosphere may undergo, in addition to and in conjunction with dilution and dispersal, a broad combination of secondary processes. Little is known about the detailed mechanism of the individual processes. Until the nature of these processes and their potential effects can be fully ascertained, tall stacks and sulfur dioxide emission limitation programs at isolated individual sources have been shown to be both appropriate and achievable control measures for attaining and maintaining ambient SO_2 standards.[17]

Coal in the presence of steam was found to act as a reductant to produce elemental sulfur from sulfur dioxide in powerplant, metallurgical, and chemical-processing flue gases. A flue gas of about 20% by volume of SO_2 was treated to produce a marketable liquid sulfur.[18]

A stack cleaner has been developed that removes both solid and gaseous waste simultaneously. Basically, the equipment centers around an impinger, which forces particulates in the gas to agglomerate with droplets of solution into which sulfur oxides were absorbed and drop out. The resulting sludge can be combined with ammonia and phosphate to produce a chemical fertilizer.[19]

A study was completed of the functional relationship between important operating variables and organic sulfur removal from coal. Temperature, pressure, and solvent-to-coal ratio were examined in a statistically designed experiment at three levels, and mathematical models of sulfur form removal as a function of these parameters were constructed. A parameter study was made of sulfur removal from coal utilizing the co-steam reaction in insitu hydrogen. Also, a study showed the overall kinetics of sulfur removal from coal during dissolution.[20]

A review of the use of sulfur in concrete showed that in addition to increased strength, the concrete had greater resistance to corrosion by sulfuric acid, reduced the quantity of steel needed in reinforcement, and increased resistance to both wear and deicing chemicals in bridge surfaces.[21]

A high-strength construction material consisting of asbestos fibers, and silica flour bonded with plasticized sulfur was developed. Potential uses of the material for handling salt and acid solution were as pipe for acid mine wastes, acidic sewer products and corrosive liquids; as linings for vats, tanks, and ditches where control of leach and waste water is essential; and as flooring in industrial operations where salt corrosion is a problem.[22]

The reaction of sulfur trioxide with metal oxides and sulfides may have potential in leaching ores. Metallic components of ores acted as catalysts in the treatment of the ores with SO_2 and oxygen to form metallic sulfates.[23]

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[15] Chemical Engineering. V. 82, No. 11, May 26, 1975, p. 63.

[16] Environmental Science and Technology. The Building of Tall (and Not So Tall) Stacks. V. 9, No. 6, June 1975, pp. 522–527.

[17] Montgomery, T. L., and J. W. Frey. Tall Stacks and Intermittent Control of SO_2 Emissions TVA Experience and Plans. Min. Cong. J., v. 61, No. 1, January 1975, pp. 44–51.

[18] Bishoff, W. F., Jr., and P. Steiner. Coal Converts SO_2 to S. Chem. Eng., v. 82, No. 1, Jan. 6, 1975. pp. 74–75.

Bishoff, W. F., and Y. Habib. Processing SO_2 the FW–BF Dry Absorption System. Chem. Eng. Process. v. 71, No. 5, May 1975, pp. 59–60.

[19] Jeffers. P. E. Dual-Purpose Stack Cleaner an Industry Breakthrough. Brick and Clay Record, v. 167, No. 4, October 1975, pp. 32–34.

[20] Colorado School of Mines. Removal of Sulfur From Coal by Treatment With Hydrogen Phase III. Fossil Energy Program Report. Energy Research and Development Administration, 1975–1976, pp. 293–296.

[21] Platou, J. Sulfur-Impregnated Concrete. Sulphur Inst. J., v. 11, No. 1, Spring 1975. pp. 2–4.

[22] McBee, W. C.,, and T. A. Sullivan. Sulphur Composite Material. Sulphur Inst. J., v. 11, No. 3–4, Fall-Winter 1975, pp. 12–14.

[23] Habashi, F. Sulfur Trioxide in Metallurgy. Sulphur Inst. J., v. 11, No. 1, Spring 1975, pp. 12–14.

Talc, Soapstone and Pyrophyllite

By J. Robert Wells [1] and Robert A. Clifton [2]

The economic recession of 1975 caused such a drop in demand for the various industrial talcs that production was the lowest since 1967, and sales were the lowest since 1968. The sales value was the lowest since 1961.

The Johns-Manville Corp. announced plans to close its Dunn, Calif., plant and to increase the capacity of its Los Angeles plant. Its mine at Warm Springs, Calif., is scheduled for a return to an underground operation in the spring of 1976.

The State of California and the U.S. Congress are eyeing some real limits on mining activities in Death Valley National Monument where several talc mines operate. As proposed, the legislation would impose a moratorium on new claims within the monument, closely examine the legitimacy of all claims issued prior to January 1, 1976, and protect the rights of the present miners at least until the effects of a ban of all mining could be studied.

Table 1.—Salient talc, soapstone, and pyrophyllite statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Mine production	1,037	1,107	1,247	r 1,289	928
Value	$7,634	$7,835	$9,144	r $9,569	$8,309
Sold by producers	979	1,084	1,184	1,064	798
Value	$26,936	$33,709	$32,226	$32,599	$17,876
Exports [1]	136	171	180	183	158
Value	$4,844	$5,791	$6,618	$6,711	$6,338
Imports for consumption	17	29	23	30	28
Value	$745	$1,669	$1,658	$2,238	$1,471
Apparent consumption	860	942	1,027	911	796
World: Production	5,221	5,324	r 5,957	r 6,284	5,345

r Revised.
[1] Excludes powders—talcum (in package), face, and compact.

Legislation and Government Programs.—Defense materials inventories reported by the General Services Administration showed that Government holdings as of December 31, 1975, included 1,149 short tons of talc (steatite, block or lump) purchased in compliance with a stockpile objective, and 2,916 short tons of talc (steatite, ground) acquired in nonstockpile transactions.

The Office of Minerals Exploration, Geological Survey, offered to grant loans of up to 50% of approved exploration costs for eligible deposits of block steatite talc, but no loans for that purpose were made in 1975. The allowable depletion rates for talc, established by the Tax Reform Act of 1969 and unchanged through 1975, were 22% on production of block steatite talc of domestic origin and 14% on foreign production of the same material, which rate applied also to production of all other classes of talc from all sources.

The Federal Register of October 9, 1975, contained the new Office of Safety and Health Administration (OSHA) proposal to go to a 0.5 fiber per cubic centimeter permissible asbestos exposure level. The talc position is still not a clear one,

[1] Former physical scientist, Division of Nonmetallic Minerals, now retired.
[2] Physical scientist, Division of Nonmetallic Minerals.

as in the text of the proposal no differentiation is made between fibrous and nonfibrous tremolite and some other amphiboles. The proposal is being fought vigorously by the asbestos industry.

Several members of the talc industry were cooperating with a joint Mining Enforcement and Safety Administration (MESA)—National Institute of Occupational Safety and Health (NIOSH) study on the health of talc workers.

DOMESTIC PRODUCTION

Mine production of crude talc and related minerals in the United States in 1975 dropped to a 7-year low and was just 72% of that produced in 1974. The value of these minerals was at a 3-year low and was 87% of 1974 value.

Mines in six States produced 95% of the tonnage and 98% of the value of the talc-group minerals in 1975, and the production in eight other States accounted for the rest. The largest producing States in decreasing order are Vermont, New York, California, Texas, Montana, and North Carolina. Every State, with the exception of Nevada, that produced these minerals had one or more mills to process the ore.

Talc was produced at 30 mines in 7 States in 1975, with California having by far the largest number of active mines at 12. Soapstone was produced in 7 States at 10 mines, 3 of which were in Texas. The six mines producing pyrophyllite in North Carolina no longer give that State a monopoly. The Interpace Corp.'s Victorite mine in California was active in 1975.

Table 2.—Talc, soapstone, and pyrophyllite produced in the United States, by State

State	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
California	r 163,881	r $1,676	152,978	$1,598
Georgia	33,850	102	27,400	82
North Carolina	110,978	993	58,514	985
Texas	192,492	1,310	129,626	795
Vermont	r 262,706	r 1,743	230,973	1,918
Other States [1]	525,595	3,745	328,057	2,931
Total	r 1,289,502	r 9,569	927,548	8,309

r Revised.
[1] Includes Alabama, Arkansas, Maryland (1974), Montana, Nevada, New York, Oregon, Virginia, and Washington.

The 10 largest domestic producers of talc minerals in 1975, listed alphabetically, were as follows: Cyprus Industrial Minerals Co., with mines in California, Montana, and Texas; Eastern Magnesia Talc Co. in Vermont; Johns-Manville Corp. in California; Pfizer Inc., Minerals, Pigments & Metals Div., in California and Montana; Piedmont Minerals Co., Inc., in North Carolina; Southern Clay Products, Inc., in Texas; Standard Minerals Co., Inc., in North Carolina; R. T. Vanderbilt Co., Inc., in New York; and Windsor Minerals, Inc., in Vermont. Those firms supplied 87% of the 1975 tonnage (79% of the total value), and the combined output of about 18 smaller producers made up the remainder.

Talc minerals were ground for sale or industrial use in 1975 at 37 mills operated by 29 companies in 12 States. Talc mined in Nevada was shipped elsewhere for grinding.

Table 3.—Talc, soapstone, and pyrophyllite sold by producers in the United States, by class
(Thousand short tons and thousand dollars)

Year	Crude		Ground		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1971	132	789	847	26,147	979	26,936
1972	90	521	994	33,188	1,084	33,709
1973	118	918	1,066	31,308	1,184	32,226
1974	114	1,294	950	31,305	1,064	32,599
1975	67	401	731	17,210	[2] 798	[2] 17,876

[1] Data may not add to totals shown because of independent rounding.
[2] Total includes sawed material.

Table 4.—Pyrophyllite produced and sold by producers in the United States

Year	Production	Sales	
	Short tons	Short tons	Value (thousands)
1971	101,030	90,477	$1,155
1972	W	90,482	1,236
1973	W	113,019	1,469
1974	105,703	101,132	1,474
1975	91,893	85,574	1,379

W Withheld to avoid disclosing individual company confidential data.

CONSUMPTION AND USES

The apparent domestic consumption of the various talc-group minerals totaled 796,000 tons in 1975, which was 13% below that of 1974 and just 78% of the record high in 1973. Sales of ground material reported for 1975 were only 77% of those in 1974. The total value of these minerals in 1975 was $15 million below that reported for the crude and ground in 1974.

The following percentages of the talc-group minerals used in major amounts by discrete industry segments reflect data reported by producers and do not correlate with table 5 because of differences in the export data and the total caused by that difference. Obviously there is some resale by original purchasers. The ceramic industry is the largest user of these minerals with 22%, paint is next with 17%, paper 8%, refractories 6%, roofing and insecticides at 5% each, toilet preparations 4%, rubber 2%, and asphalt filler 1%.

Table 5.—Talc, soapstone, and pyrophyllite sold or used by producers in the United States, by use
(Short tons)

Use	1974	1975
Asphalt filler	12,186	9,188
Ceramics	221,365	185,138
Exports [1]	182,706	157,681
Insecticides	47,088	41,966
Paint	157,792	140,672
Paper	88,519	67,252
Refractories [2]	r 46,612	50,290
Roofing	45,867	39,505
Rubber	25,123	15,764
Textiles	14,428	3,158
Toilet preparations	34,628	31,241
Other uses [3]	r 187,771	189,345
Total	1,064,085	931,200

r Revised.
[1] Department of Commerce, Bureau of the Census data.
[2] Includes pyrophyllite used for brick manufacture.
[3] Includes art sculpture, crayons, floor tile, foundry facings, plastics, rice polishing, stucco, and other uses, not specified.

Generalizations and/or extrapolations to the broad economic picture are not likely to be valid, but the change in demand for talc-group minerals during a recession provides an interesting picture. Only the refractories industry purchased more in 1975 than in 1974 with an 8% increase. Toilet preparations usage was at 90% of the 1974 level, insecticides and paint at 89%, roofing 86%, ceramics 84%, paper 76%, asphalt filler 75%, rubber 63%, and textiles just 22%.

STOCKS

According to estimates based on data reported by producers, the total quantity of crude, ground, and partly processed talc-group minerals of domestic origin on hand in the United States (that is, mined but not yet sold or used) was approximately 255,000 tons on December 31, 1975, compared with 225,000 tons on that date in 1974.

PRICES

Engineering and Mining Journal, December 1975, quoted prices for domestic talc, ground, in carload lots, f.o.b. mine or mill, containers included, per short ton, as follows:

Vermont:	
98% through 325 mesh, bulk	$27.00
99.99% through 325 mesh, bags:	
Dry processed	70.00
Water beneficiated	100.00
New York:	
96% through 200 mesh	34.00
98% to 99.25% through 325 mesh	$36.00– 43.00
100% through 325 mesh, fluid energy ground	53.00– 95.00
California:	
Standard	69.50
Fractionated	37.00– 71.00
Micronized	62.00–104.00
Cosmetic/steatite	44.00– 65.00
Georgia:	
98% through 200 mesh	20.00
99% through 325 mesh	35.00
100% through 325 mesh, fluid energy ground	85.00

American Paint & Coatings Journal, June 7, 1976, listed the following prices per ton for paint-grade talcs in carload lots:

California:	
325 mesh, bags, mill:	
Fibrous, white, high oil absorption	$34.00–$37.00
Semifibrous, medium oil absorption	32.00– 73.95
Montana:	
Ultrafine grind, f.o.b. mill	70.00
New York:	
Nonfibrous, bags, mill:	
98% through 325 mesh	46.50– 50.50
99.4% through 325 mesh	55.50
Trace retained on 325 mesh	105.00
Fine micron talcs (origin not specified)	68.00–111.50

The price range quoted in Chemical Marketing Reporter, December 29, 1975, for carload lots of imported Canadian talc, ground, in bags, was from $20 to $35 per ton, f.o.b. works.

The approximate equivalents, in dollars per short ton, of the price ranges quoted in Industrial Minerals (London), December 1975, for steatite talc, c.i.f. main European port, were as follows:

Norwegian: Ground (ex store)	$54.00–$59.00
Micronized (ex store)	85.00–134.00
French, fine ground	72.00–169.00
Italian, cosmetic grade	161.00–207.00
Chinese	107.00–132.00

FOREIGN TRADE

Exports.—The general sluggishness of the 1975 talc market was reflected in foreign trade figures. The quantity of talc-group minerals exported from the United States in 1975 was 14% less in tonnage and 6% less in total value than in 1974. The largest share of the exported material went to destinations in Mexico, followed in descending order by Canada, Belgium-Luxembourg, and Venezuela. Shipments to these countries accounted for 89% of the 1975 tonnage and 77% of the corresponding total value; the remainder was distributed among about 50 other countries.

Table 6.—U.S. exports of talc, soapstone, and pyrophyllite, crude and ground
(Thousand short tons and thousand dollars)

Year	Quantity	Value
1973	180	6,618
1974	183	6,711
1975	158	6,338

Imports.—In 1975 U.S. imports for consumption of talc, steatite, or soapstone in unmanufactured form were 23% less in tonnage and 34% less in total value than in 1974. Total value of U.S. imports in the Census Bureau's classification "Talc, steatite, and soapstone and articles of these, not specially provided for" amounted to $198,090, a decrease of 12% from the 1974 figure. As in 1974 the foremost supplier of this class of material (with 47% of the 1975 total) was the People's Republic of China.

Tariffs.—Schedules applicable throughout 1975 were unchanged from those in 1974.

Table 7.—U.S. imports for consumption of talc, steatite, or soapstone, by class and country

Year and country	Crude and unground		Ground, washed, powdered, or pulverized		Cut and sawed		Total unmanufactured	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value[1] (thousands)
1973	14,467	$690	7,770	$436	756	$532	22,993	$1,658
1974:								
Australia	--	--	--	--	(2)	2	(2)	2
Austria	--	--	--	--	1	1	1	1
Brazil	--	--	23	2	--	--	23	2
Canada	5,593	58	4,717	213	1	1	10,311	272
China, Peoples Republic of	--	--	223	11	--	--	223	11
France	3,903	120	1,361	81	--	--	5,264	201
Hong Kong	--	--	--	--	323	205	323	205
India	--	--	--	--	2	1	2	1
Israel	--	--	20	5	--	--	20	5
Italy	12,087	910	914	152	7	15	13,008	1,077
Japan	9	7	--	--	355	281	364	288
Korea, Republic of	--	--	599	77	114	91	713	168
Total	21,592	1,095	7,857	541	803	597	30,252	2,233
1975:								
Australia	--	--	--	--	(2)	(2)	(2)	(2)
Canada	3,447	76	3,233	174	5	2	6,685	252
France	4,432	110	4,802	170	--	--	9,234	280
Germany, West	--	--	--	--	(2)	1	(2)	1
Hong Kong	--	--	--	--	29	19	29	19
Iceland	--	--	20	2	--	--	20	2
Israel	--	--	34	8	--	--	34	8
Italy	6,063	476	356	72	--	--	6,419	548
Japan	--	--	--	--	271	213	271	213
Korea, Republic of	--	--	559	68	127	79	686	147
United Kingdom	(2)	1	--	--	--	--	(2)	1
Total	13,942	663	9,004	494	432	314	23,378	1,471

[1] Does not include talc, n.s.p.f.; 1973, $230,997; 1974, $224,375; 1975, $198,090.
[2] Less than ½ unit.

WORLD REVIEW

An article in an industrial journal presented an analysis of the manifold aspects of today's worldwide talc industry. The most prominent producers in several of the major talc producing countries were identified, the locations and geological characteristics of their deposits were described, and some information was reported concerning the beneficiation procedures and production capacities of those organizations. Attention was given in some detail to the talc scene in about 20 individual countries ranging alphabetically from Afghanistan to Zambia. Talc-group consumption patterns in the more industrialized nations were outlined, and a concise summary was included showing the ramifications of the international export-import trade in talc minerals.[3]

[3] Industrial Minerals (London). Talc Today—The Culmination of Twenty Years' Growth. No. 91, April 1975, pp. 15–17, 19–23, 25, 27–31.

Table 8.—Talc, soapstone, and pyrophyllite: World production by country

(Short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Canada (shipments)	81,495	94,746	74,000
Mexico	2,324	2,920	1,631
United States	1,246,534	1,289,502	927,548
South America:			
Argentina	49,097	[e] 57,000	[e] 57,000
Brazil (talc and pyrophyllite)	151,031	221,767	[e] 223,000
Chile	1,938	1,856	524
Colombia	992	882	[e] 880
Paraguay	276	276	[e] 280
Peru	88,132	[r] [e] 88,000	[e] 88,000
Uruguay	2,201	2,287	[e] 2,200
Europe:			
Austria	101,638	108,511	95,363
Finland	120,928	141,392	136,973
France (ground talc)	[r] 284,187	328,852	284,396
Germany, West (marketable)	32,754	31,429	[e] 33,000
Greece (steatite)	[r] 5,788	4,762	[e] 5,000
Hungary [e]	17,600	17,600	17,600
Italy (talc and steatite)	[r] 162,108	170,819	[e] 151,900
Norway	150,396	124,590	[e] 132,000
Portugal	1,224	1,091	1,731
Romania [e]	66,000	66,000	66,000
Spain	[r] 44,240	60,625	[e] 60,600
Sweden	30,897	31,310	29,762
U.S.S.R. [e]	440,000	450,000	460,000
United Kingdom	[r] 22,046	23,149	[e] 24,000
Africa:			
Afghanistan [2]	--	3,307	6,945
Angola [e]	110	110	110
Egypt	7,756	4,345	5,700
Ethiopia	--	3	[e] 3
South Africa, Republic of [3]	13,055	19,951	[e] 22,000
Sudan	--	5,512	[e] 5,500
Swaziland (pyrophyllite)	139	40	--
Zambia	1,467	152	[e] 110
Asia:			
Burma	[r] 139	456	331
China, People's Republic of [e]	165,000	165,000	165,000
India	[r] 247,923	291,765	220,596
Japan [4]	[r] 1,717,742	1,734,878	1,313,489
Korea, North [e]	120,000	130,000	140,000
Korea, Republic of (talc and pyrophyllite)	460,963	487,322	458,423
Nepal [5]	49	278	571
Pakistan (talc and soapstone)	[r] 6,572	7,776	[e] 7,400
Philippines	1,801	2,572	1,479
Taiwan	[r] 27,929	14,900	13,282
Thailand (talc and pyrophyllite)	10,610	1,982	11,736
Oceania: Australia	71,439	94,448	[e] 99,000
Total	[r] 5,956,520	6,284,163	5,345,063

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, Southern Rhodesia is believed to produce talc, but available information is inadequate to make reliable estimates of output levels.

[2] Calendar year begins March 20 of year stated.

[3] Includes talc and wonderstone (pyrophyllite).

[4] Includes talc and pyrophyllite; in addition, pyrophyllite clay was produced as follows in short tons: 1973—[r] 349,196; 1974—466,030; 1975—377,300.

[5] Data based on Nepalese fiscal year, beginning mid-July of year stated.

TECHNOLOGY

Variations in rare-earth elements distribution in soapstone from different eastern Virginia quarries has led to an unusual method of affirming prehistoric sociopolitical boundaries according to a prominent magazine.[4] The variations, measured by neutron activation analysis enabled tracing of soapstone artifacts to their original quarries and so delineated trading routes and boundaries.

A great deal of research money was being expended by two groups in the continuing controversy over whether or not some or all of the talc minerals with or without a tremolite constituent should be covered by the asbestos regulations of MESA and those of OSHA. At yearend OSHA Field Memo #74–92 was in effect and it stated: "Fibrous, asbestiform minerals such as fibrous tremolite means naturally occurring asbestiform minerals which prior to, or after crushing and processing, contain fibers made up of fibrils," and companies were being cited by OSHA under the asbestos regulations.

An OSHA proposal for changes in the asbestos regulations published October 9, 1975, in the Federal Register,[5] described the three most commonly used asbestos fibers as the fibrous forms of their respective host or matrix minerals. Tremolite, in the same proposal, is simply described as a calcium magnesium silicate. No word denoting fiber is in the description yet it is included among the asbestos minerals. The new proposal is being contested by the minerals industry, particularly the asbestos and talc segments of that industry, along many lines, including mineralogy.

[4] Science. V. 187, No. 4171, January 10, 1975, pp. 57–58.
[5] Federal Register, Vol. 40, No. 197, Oct. 9, 1975, pp. 47652–47665.

Thorium

By Rebecca P. Smith [1]

Monazite, the principal source of thorium, continued to be recovered as a byproduct at two mines in Florida by Humphreys Mining Co. and Titanium Enterprises. Thorium was extracted from monazite during rare-earth recovery and stored for future use. Thus, production of thorium was in excess of demand. Practically all thorium compounds used by the domestic industry during 1975 came from previous company stocks or imports.

No major developments occurred in the nonenergy uses of thorium, which included mantles for incandescent lamps, hardeners in magnesium alloys, refractories, and electronic and chemical applications.

Because of the decline in energy consumption and delays in starting up the 330-megawatt electric (Mwe) high-temperature gas-cooled reactor (HTGR) near Greeley, Colo., all orders for other HTGR's were cancelled by General Atomic Co. (GA), the manufacturer, or by the power companies. The future prospects for use of thorium in nuclear fuels remained uncertain. However, research continued on development of a thorium-fueled light-water breeder reactor (LWBR) and a gas-cooled fast-breeder reactor (GCFR), which breeds U_{233} from Th_{232}. The large-scale development, either of these reactors or of a modified Canadian-deuterium-uranium (CANDU) reactor under consideration by the Federal Government, could substantially increase the consumption of thorium.

DOMESTIC PRODUCTION

Exploration.—New occurrences of thorium were discovered in 1975 as a result of exploration for other commodities. Thorian uranite and thorogummite were peported in an abandoned serpentine-talc quarry located in Northamption County, Pa.[2] Buttes Gas & Oil Co. began a study of a large deposit of titanium in southwestern Colorado believed to contain a significant amount of thorium. In December, the Energy Research and Development Administration (ERDA) established a regional office in Atlanta, Ga., to evaluate the potential of uranium and thorium resources in the Southeast.

Mine Production.—In 1975, as in the past, thorium was extracted as a byproduct during the recovery of rare-earth elements from monazite, which was separated from beach sands mined for titanium minerals. Humphreys Mining Co. near Hilliard, Fla., and Titanium Enterprises near Green Cove Springs, Fla., were the only domestic producers of thorium. Humphreys Mining Co. trucked wet concentrates from its mine in Florida to its dry plant at Folkston, Ga. U.S. mine production of thorium in 1975 was slightly above the 1974 production.

Refinery Production.—During 1975, only one domestic firm, W. R. Grace & Co., Davison Chemical Div., at Chattanooga, Tenn., had facilities for processing large tonnages of monazite. Although W. R. Grace did not produce any thorium compounds from monazite to sell, thorium was extracted during the refining of rare-earth elements and stored. Virtually all thorium compounds used domestically during 1975 came from company stocks or imports.

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[1] Physical scientist, Division of Nonferrous Metals.

[2] Smith, B. C. II. New Uranium-Thorium Occurrence in Northampton County, Pa. Geol., v. 6, No. 6, December 1975, p. 11.

Table 1.—Companies with thorium processing and fabricating capacity

Company	Plant location	Operations and products
American Light Alloys, Inc	Little Falls, N.J	Magnesium-thorium alloy.
Consolidated Aluminum Corp	Madison, Ill	Do.
Controlled Castings Corp	Plainview, N.Y	Do.
Gallard-Schlesinger Chemical Manufacturing Corp.	Carle Place, N.Y	Processes oxide, fluoride, metal.
General Atomic Co	San Diego, Calif	Nuclear fuels.
General Electric Co	San Jose, Calif	Do.
Do	Wilmington, N.C	Do.
W. R. Grace & Co	Chattanooga, Tenn	Processes domestic and imported monazite, produces oxide, stocks hydroxide and metal powder.
Gulf United Nuclear Fuels Corp	Hematite, Mo	Nuclear fuels.
Do	New Haven, Conn	Do.
Hitchcock Industries, Inc	South Bloomington, Minn	Magnesium-thorium alloys.
Kerr-McGee Chemical Corp	Cimarron, Okla	Nuclear fuels.
NL Industries, Inc	Albany, N.Y	Do.
Nuclear Chemicals and Metals Corp.	Huntsville, Tenn	Do.
Nuclear Fuels Services, Inc	Erwin, Tenn	Do.
Nuclear Materials & Equipment Corp. (NUMEC)	Apollo, Pa	Do.
Do	Leechburg, Pa	Do.
Ventron Corp., Chemicals Div	Beverly, Mass	Metallic thorium.
Westinghouse Electric Corp	Bloomfield, N.J	Processes compounds and produces metallic thorium.
Do	Columbia, S.C	Nuclear fuels.

CONSUMPTION AND USES

Based on domestic mine production, releases from the Government stockpile, and foreign trade, the estimated apparent domestic consumption of thorium in monazite and thorium compounds for 1975 was 218 short tons of ThO_2 equivalent. However, monazite was processed mainly for its rare-earth content and thorium residues were stored. Actual industrial demand was about 50 tons of ThO_2 equivalent, based mainly on shipments from processors. This is considerably below the 1974 consumption of 80 tons. The decline in consumption during 1975 was mainly due to low demand in energy applications.

Nonenergy uses consumed about 35 tons of ThO_2. The principal application was a constituent in mantles for Welsbach incandescent lamps (estimated to be around 20 tons). Other nonenergy uses were: As a hardener for magnesium-thorium alloys, 4 tons; in refractories, 5 tons; in electronic and chemical applications, plus other applications and research, 6 tons.

The 330-Mwe plant at Fort St. Vrain, Colo., was in the power ascension phase, and operation at 2% power was achieved in May 1975. It is the only licensed HTGR; all other orders for HTGR's were cancelled by GA or by the power companies. In 1975, thorium consumption in energy-related applications was estimated at 15 tons ThO_2. ERDA remained the principal domestic user of thorium. Besides the HTGR-related applications, research continued on the use of thorium in the LWBR, and on the refining and processing of thorium-containing nuclear fuel.

STOCKS

On December 31, 1975, the Government stockpile totaled 7,282,749 pounds of thorium nitrate. The thorium stockpile objective was zero.

Industrial stocks of thorium at the end of 1975 were above previous levels, especially at consuming plants. This was mainly due to a decrease in demand for processing monazite for rare-earth elements. Estimated industrial stocks at yearend as ThO_2 equivalent were monazite, 124 tons, and in compounds and metal, 350 tons.

PRICES

Prices for domestic monazite containing approximately 4% ThO_2 remained stable during the year, and were comparable to 1974 prices. The average declared value of imported monazite from Malaysia and Thailand increased to $207 per short ton from $152 in 1974. The average price per short ton of Australian monazite quoted in Metal Bulletin (London) remained constant during 1975 at $203.

Prices for thorium compounds varied with purity and quantity. An average range of prices was: Nitrate, wire grade 47% ThO^2, $2.95–$3; nitrate, mantle grade, 47% ThO_2, $3–3.10; ThO_2, ceramic grade, 99.9% ThO_2, $6–$12; and ThO_2, nuclear grade, 99% ThO_2, $8–12.

Thorium metal in pellets remained steady at $15 per pound as quoted in the American Metal Market.

FOREIGN TRADE

During 1975, no thorium concentrates or ores were exported. Statistics on other thorium products exported are combined with those of uranium. Although these two elements are not statistically differentiated, it was believed that the amount of thorium exported is minor.

Imports of monazite, mainly for rare-earth content, increased above the 1974 level. As in the past, Malaysia was the principal supplier. In 1975 imports of gas mantles decreased, but imports of thorium compounds, mainly from France, increased.

Table 2.—U.S. foreign trade in thorium and thorium-bearing materials

(Quantity in pounds unless otherwise specified)

	1973		1974		1975		Principal sources and destinations, 1975
	Quantity	Value	Quantity	Value	Quantity	Value	
EXPORTS							
Ore and concentrate (ThO_2 content)	2,183	$13,724	156,430	$270,252	--	--	
Metals and alloys [1]	14,737	269,708	20,496	321,982	14,840	$203,415	Japan 8,496; Italy 2,732; Australia 1,762; Canada 1,155; Denmark 525; Greece 125; other 45.
Compounds [1]	4,028,095	26,107,130	4,682,926	30,855,227	3,837,266	52,039,852	Canada 1,845,212; West Germany 701,851; United Kingdom 676,872; France 444,941; Netherlands 158,714; Taiwan 5,232; Sweden 3,411; Japan 734; Mexico 199; other 100.
IMPORTS							
Ore and concentrate:							
Monazite (short tons)	1,876	254,125	r 1,320	r 200,527	2,565	531,958	Malaysia 2,462; Thailand 103.
ThO_2 content [e]	r 225,120	XX	158,400	XX	307,800	XX	
Waste and scrap	20	280	15	303	115	2,165	All from Canada.
Compounds:							
Nitrate	2,200	3,104	8,083	13,939	66,102	118,343	All from France.
Oxide	1,603	5,811	12,000	48,781	9,500	55,382	Do.
Oxide equivalent, in gas mantles [e 2]	3,882	453,692	3,349	399,545	2,374	361,268	United Kingdom 1,099; Malta 660; Austria 210; Brazil 182; Italy 77; other 146.
Other	177	32,754	172	23,394	76	18,438	Switzerland 70; West Germany 6.

[e] Estimate. [r] Revised. XX Not applicable.

[1] Includes uranium; thorium and uranium are undifferentiated in official statistics.

[2] Based on manufacture of 1,000 gas mantles per pound ThO_2.

WORLD REVIEW

The predominate source of the world's thorium is monazite, a byproduct of titanium and tin mining. Australia, India, Malaysia, Brazil, and the United States continued to be the leading monazite producers among market-economy countries. The small world demand for thorium however, is not reflected by the quantity of this production, since monazite is processed mainly for its rare-earth-element content.

Table 3.—Monazite concentrates: World production by country
(Short tons)

Country [1]	1973	1974	1975 p
Australia	4,725	4,206	4,704
Brazil	r 1,586	e 1,650	e 1,650
India	3,858	e 3,300	e 3,300
Korea, Republic of	10	e 10	e 10
Malaysia [2]	2,141	1,965	e 1,900
Mauritania	(3)	(3)	--
Nigeria	6	12	e 12
Sri Lanka	e 10	7	e 10
Thailand	351	486	405
United States	W	W	W
Zaire	250	261	328
Total	r 12,937	11,897	12,319

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing company confidential data.
[1] In addition to the countries listed, Indonesia and North Korea may produce monazite, but information is inadequate to make reliable estimates of output levels.
[2] Exports.
[3] Revised to zero.

Australia.—According to the Rutile & Zircon Development Association, Ltd., monazite production by member companies in 1975 was, by state, New South Wales, 1,207 short tons; Queensland, 685 short tons; and Western Australia, 3,252 short tons.

Allied Eneabba Pty. Ltd. began production at its heavy mineral sands project. The company mine and wet concentrator were located near Eneabba and a dry separation plant was planned at Meru, the port of export.[3] Reserves were estimated at 220,000 short tons of monazite in the Eneabba minerals field.

Other companies with interest in the Eneabba minerals field of Western Australia included: Jennings Mining Ltd., which was producing heavy minerals; Western Titanium Ltd.; and Western Mining Corp. Ltd., and Mineral Sands Pty. Ltd. which have projects in the area. International Nickel Australia, Ltd., subsidiary of the International Nickel Co. of Canada, Ltd., filed an application to search for monazite and other related heavy minerals in the Eneabba area.[4]

Germany, West.—The 300-Mwe pebble-bed thorium high-temperature reactor (THTR) was under construction at the Hamm-Uentrop station of the power company Vereinigte Elektrizitaetswerke Westfalen AG (VEW). The completion of the THTR developed by Hochtemperatur-Reaktorbau GmbH (HRB) was scheduled for 1977.[5]

According to its studies, HRB concluded that coal gasification by nuclear heat was commercially attractive and technically feasible.[6] It is possible that THTR will be used as the high-temperature reactor for an integrated nuclear process heat-electricity system.

India.—A monazite sand separation plant in Gopalpur in Southern Orissa was under construction by the Government-owned Indian Rare Earths, Ltd. Estimated initial annual production is 4,400 short tons of monazite, which will be a byproduct of ilmenite and rutile mining.[7] This will substantially add to the monazite production of India, which was estimated to be 3,300 short tons in 1975.

India's National Institute of Oceanography conducted an extensive survey of

[3] Skillings' Mining Review. Allied Eneabba Mineral Sands Project. V. 64, No. 35, August 30, 1975, p. 17.
[4] Industrial Minerals. No. 94, July 1975, p. 35.
[5] Nuclear Industry. KWU, German Vendor, Gets Several Orders at Home, Two from Brazil. V. 22, No. 7, July 1975, pp. 34–35.
[6] Harder, H., and R. Fisher. Nuclear Process Heat Programs in Germany. Nuclear News, v. 18, No. 4, March 1975, pp. 56–62.
[7] U.S. Embassy, New Delhi, India. State Department Airgram A-389, Dec. 17, 1975, p. 4.

shallow offshore areas for heavy minerals. According to the Institute, India's beaches are rich in heavy mineral placers, containing magnetite, ilmenite, monazite, and garnet.[8]

Liberia.—According to a cooperative study of the U.S. Geological Survey and the Liberian Geological Survey, Liberian coastal sands may contain sufficient monazite and other heavy minerals for profitable extraction. The coastal monazite analyzed 7.2% ThO_2.[9]

South Africa, Republic of.—The proposed major beach sands mining operation north of Richards Bay on the east coast was dependent on completing financial arrangements. The proposed mining area will be approximately 11 miles long by 2 miles wide. Monazite will probably be recovered as a byproduct of the more important economic minerals, rutile and zircon. Final output was expected to be about 75,000 tons of rutile and 150,000 tons of zircon per year.[10]

Sri Lanka.—Work continued at Pulmoddai Beach by the Mineral Sands Corp. of Sri Lanka on installing the infrastructure for a mineral sands plant scheduled to come onstream by 1980.[11] The new complex will have an estimated annual capacity of 500 tons of monazite.

United Kingdom.—Thorium Ltd., a subsidiary of Rio Tinto Zinc, Ltd., Widnes, England, stopped processing monazite as of November 1975.[12] Thorium Ltd. was founded in 1914 to supply the United Kingdom with thorium nitrate for gas mantles.

TECHNOLOGY

Nonenergy research on thorium included studies of metallurgy, separation techniques, abundance, use in geochronology, heat capacity of compounds and metals, superconductivity of its compounds, and reaction of thorium with other elements or compounds.

Experiments on thoria-dispersed magnesium were included as a part of a study involving the processing of materials in near-weightlessness. This is the first part of a 5-year series to be conducted by the National Aeronautics and Space Administration aboard an unmanned rocket.[13]

A summary of data on the thermodynamic properties of thorium and its alloys was reported.[14]

The effect of nitrogen in solid solution on the strength of polycrystalline thorium was the subject of another study. Nitrogen was found to behave similarly to carbon in thorium, as a strong, short-range obstacle to dislocation motion.[15]

A fast and simple technique was developed to separate Th_{277} from the Ac_{277} series.[16]

Another separation technique using adsorption by anion-exchange followed by separation by elution with acid was developed to separate thorium, zirconium, and uranium from silicate rocks.[17]

Several studies have been directed toward the behavior of thorium chlorides in fused chloride salts. One study investigated the reduction of $(Th,U)O_2$ with thorium metal to produce ThO_2 and uranium metal. It may be possible to use this reaction as the first step in the reprocessing of $(Th,U)O_2$ fuel and the separation of uranium for the refabrication of new fuel.[18]

Thorium-related energy research was directed mostly toward reprocessing of thorium fuels, process heat, and the GCFR. Since the cancellation of HTGR orders, research has been reduced, but is likely to revive because of the reactor's possible use in nuclear process heat plants.

ERDA was considering recommending the construction of an integrated HTGR re-

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[8] Engineering and Mining Journal. V. 176, No. 12, December 1975, p. 124.

[9] Rosenblum, S. Analyses and Economic Potential of Monazite in Liberia. U.S. Geol. Survey. J. Res., v. 2, No. 6, November–December 1974, pp. 689–692.

[10] Mining Magazine. Go-Ahead Announced for South African Beach Sands Project at Richards Bay. V. 133, No. 6, December 1975, p. 421.

[11] Mining Magazine. Sri Lanka Project. V. 133, No. 6, December 1975, p. 485.

[12] Cannon, J. G. Rare Earths-Supply Ample in 1975; New Markets Promise Continued Demand Growth. Eng. Min. J., v. 177, No. 3, March 1976, pp. 184–189.

[13] Chemical & Engineering News. V. 53, No. 44, Nov. 3, 1975, p. 22.

[14] Kubaschewski, O. (ed.) Thorium: Physico-Chemical Properties of its Compounds and Alloys. Atom. Energy Rev., No. 5, 1975, pp. 1–241.

[15] Peterson, D. T., and D. R. McLachlan. Effect of Nitrogen on the Strength of Thorium. Met. Trans., v. 6A, No. 7, July 1975, pp. 1359–1366.

[16] Aly, H. F. Fast and Simple Radiochemical Separation of ^{277}Th from the ^{277}Ac Series. Radiochem. Radioanal. Lett., v. 21, No. 5, May 24, 1975, pp. 301–506.

[17] Glass Technology V. 16, No. 6, December 1975, p. 98A.

[18] Chiotti, P., M. C. Jha, and M. J. Ischetter. Reaction of Thorium and $ThCl_4$ With UO_2 and $(Th,U)O_2$ in Fused Chloride Salts J. Less-Common Metals, v. 42, No. 2, September 1975, pp. 141–161.

processing and fabricating demonstration plant. Much of the conceptual engineering work was completed. The demonstration plant was scheduled to have a capacity for handling 2,500 fuel elements per year, and could be expanded to a capability of about 10,000 fuel elements per year.[19]

Allied Chemical Corp. continued research on developing a process for recovering uranium and thorium from Fort St. Vrain fuel. The process involved primary burning of the graphite, separation of the particles by a gas classifier, particle breaking by gas jets, secondary burning, and then final separation and processing.[20]

Experiments to verify theoretical physics calculations for a GCFR nuclear power system were underway by GA, ERDA, and the Argonne National Laboratory. The GCFR utilizes the coolant and nonnuclear component technology of the conventional HTGR. GA expects the GCFR to produce nearly 40% more fuel than it consumes. In the breeder, "fertile" uranium and thorium will be transmuted into fissionable materials. The fissionable material, U_{233}, can be used to fuel the HTGR.

[19] Nuclear News. V. 18, No. 10, August 1975, pp. 115–116.

[20] Hogg, G. W., J. A. Rindfleisch, W. B. Palmer, D. L. Anderson, and J. S. Vavruska. Interim Results: Development of a Head-End Process for Recovering Uranium and Thorium from Crushed Fort St. Vrain Fuel. Idaho Chemical Programs, Operations Office, October 1975, 107 pp.

Tin

By Keith L. Harris [1]

A world recession caused decreased demand for tin, forcing the International Tin Council (ITC) to place export controls on member producing nations to keep tin prices above the ITC established floor price. World mine production declined 4% from the 1974 level to 225,195 metric tons.[2] The buffer stock increased from 142 tons at yearend 1974 to 20,071 tons at yearend 1975. Tin prices on world markets declined substantially from the record levels attained the previous year.

U.S. consumption of primary and secondary tin decreased 15% to 55,800 tons. The major uses for tin were in tinplate, 34%; solder, 27%; bronze and brass, 14%; chemicals including tin oxide, 7%; and babbitt, 5%. Most of the nation's tin, in the form of slabs, bar, and ingots, came from Malaysia and Thailand. Less than 100 tons of tin came from mines in Alaska, Colorado, and New Mexico. About one-fifth of the tin used in the United States in 1975 was reclaimed from scrap.

[1] Physical scientist, Division of Nonferrous Metals.
[2] Unless otherwise specified all units are metric tons of contained tin.

Table 1.—Salient tin statistics
(Metric tons)

	1971	1972	1973	1974	1975
United States:					
Production:					
Mine	W	W	W	W	W
Smelter	4,064	4,369	4,877	6,096	6,500
Secondary	20,419	20,504	20,806	19,200	15,856
Exports (including reexports)	2,298	1,152	3,461	8,550	3,596
Imports for consumption:					
Metal	47,693	53,293	46,581	40,238	44,366
Ore (tin content)	3,109	4,284	4,875	5,971	6,415
Consumption:					
Primary	52,814	54,360	59,075	52,439	43,620
Secondary	18,259	15,952	16,763	13,341	12,180
Prices, average cents per pound:					
Straits tin, in New York	167.34	177.47	227.56	396.27	339.82
Straits tin, ex-works Penang	156.87	168.24	214.10	355.72	303.55
World production:					
Mine	235,959	244,183	r 237,847	r 233,747	225,195
Smelter	235,623	240,124	r 233,874	r 228,341	230,055

r Revised.
W Withheld to avoid disclosing individual company confidential data.

Table 2.—Tin statistics

(Metric tons)

Year	United States								World mine production [3]
	Production			Imports		Exports and reexports	Consumption [1]	Price cents per pound [2]	
	Mine	Smelter	Secondary	Metal	Ore (tin content)				
1900	--	--	--	31,746	--	--	31,746	29.90	83,980
1901	--	--	--	33,820	--	--	33,820	26.54	89,816
1902	--	--	--	38,575	--	--	38,575	26.79	90,293
1903	--	--	--	37,710	--	--	37,710	28.09	94,761
1904	72	--	--	37,623	--	--	37,623	27.99	95,343
1905	--	--	--	40,087	--	--	40,087	29.77	101,384
1906	64	--	--	45,782	--	--	45,782	43.67	107,043
1907	55	--	1,507	37,429	--	--	37,429	35.05	106,227
1908	27	--	2,530	37,437	--	--	37,437	29.54	113,401
1909	18	--	5,003	43,238	--	--	43,238	29.76	118,663
1910	37	--	12,612	47,653	--	--	47,653	34.27	118,379
1911	64	--	13,341	48,559	--	--	48,559	42.68	119,798
1912	118	--	13,971	52,631	--	--	52,631	46.43	128,966
1913	50	--	12,862	47,472	--	--	47,472	44.23	135,710
1914	94	--	11,291	43,119	--	--	43,119	35.70	128,210
1915	92	--	12,384	52,428	501	346	52,082	38.66	129,450
1916	127	2,051	15,784	62,627	7,294	456	64,222	43.48	128,430
1917	100	5,502	17,599	65,468	8,214	267	70,713	61.65	134,760
1918	63	9,329	21,625	64,641	16,686	258	73,712	86.80	127,970
1919	51	11,100	21,803	40,687	17,414	346	51,441	65.54	123,132
1920	20	16,014	21,319	56,967	30,978	942	72,039	50.36	123,137
1921	4	10,470	15,331	24,585	13,916	1,415	33,640	30.00	110,551
1922	1	8,263	17,700	61,159	12,523	1,115	68,306	32.58	127,077
1923	2	6,773	27,406	70,040	2,735	1,063	75,751	42.71	130,547
1924	6	441	28,395	66,103	157	974	65,570	50.20	142,509
1925	12	--	28,077	77,876	194	947	76,929	57.90	147,443
1926	7	--	30,300	78,397	308	2,012	76,386	65.30	145,860
1927	24	--	33,475	72,284	124	2,275	70,009	64.37	162,241
1928	43	--	32,477	79,221	132	1,643	77,578	50.46	181,259
1929	36	--	31,117	88,525	130	1,961	86,564	45.19	196,098
1930	15	--	23,768	82,030	294	2,269	79,761	31.70	178,825
1931	4	--	17,963	67,124	--	1,688	65,437	24.46	149,359
1932	--	--	13,381	35,378	17	1,135	34,243	22.01	96,525
1933	3	--	20,049	64,741	24	1,058	63,683	39.12	90,428
1934	8	--	22,590	40,628	2	1,236	39,392	52.16	122,332
1935	45	--	25,311	65,289	181	2,329	62,961	50.39	137,472
1936	103	--	25,420	77,249	182	392	76,857	46.42	181,873
1937	171	--	27,488	89,529	153	318	91,577	54.24	214,387
1938	97	--	21,419	50,497	--	208	60,733	42.26	165,616
1939	35	--	26,455	71,227	508	2,139	83,751	50.18	171,509
1940	50	1,413	30,139	126,813	3,048	2,707	98,713	49.82	242,125
1941	57	1,869	38,132	143,134	29,130	1,112	136,856	52.01	249,542
1942	6	16,427	34,399	27,182	29,397	416	87,062	52.00	123,247
1943	6	21,834	34,311	12,110	22,208	1,798	81,629	52.00	144,990
1944	5	31,380	29,565	13,552	36,118	857	91,413	52.00	102,621
1945	--	41,125	31,872	8,629	34,016	896	84,925	52.00	88,396
1946	--	44,198	25,104	15,809	38,691	895	82,242	54.58	89,920
1947	1	33,834	27,266	25,299	29,882	476	89,514	77.94	115,822
1948	5	37,292	27,329	49,986	38,094	92	92,245	99.25	156,472
1949	69	36,409	22,591	61,191	38,926	156	73,568	99.32	163,889
1950	96	33,650	32,188	84,168	26,377	812	106,141	95.56	172,017
1951	89	32,363	31,239	28,708	30,096	1,537	89,584	128.31	172,119
1952	101	23,171	29,267	81,836	26,916	386	79,402	120.44	176,894
1953	57	38,165	28,045	75,767	36,550	206	87,015	95.77	192,745
1954	208	27,847	26,612	66,652	22,495	835	84,221	91.81	191,830
1955	101	22,687	28,798	65,855	20,435	1,125	91,935	94.73	200,365
1956	--	17,914	29,913	63,595	16,956	904	91,793	101.26	202,702
1957	--	1,589	21,601	57,059	96	1,556	83,831	96.17	203,616
1958	--	--	23,176	41,809	5,527	1,363	73,750	95.09	155,964
1959	60	W	23,786	44,277	10,946	1,393	78,615	102.01	164,092
1960	10	W	22,404	40,173	14,251	871	81,853	101.40	183,295
1961	W	W	22,038	39,538	9,060	813	79,506	113.27	187,055
1962	W	W	21,378	42,065	5,450	442	80,354	114.61	189,900
1963	W	W	22,690	43,978	1,676	1,651	79,560	116.64	194,117
1964	66	W	23,885	32,648	5,273	4,105	84,177	157.72	196,562
1965	48	3,148	25,478	41,471	4,304	2,874	85,314	178.17	204,342
1966	99	3,886	25,756	42,368	4,442	2,893	86,834	164.02	211,411
1967	W	3,097	23,030	51,029	3,307	2,519	81,932	153.02	218,457
1968	W	3,508	22,856	58,279	2,319	4,567	83,276	148.11	230,261
1969	W	351	23,141	65,992	--	2,950	82,086	164.44	229,348
1970	W	--	20,322	51,365	4,742	4,523	75,022	174.14	232,167
1971	W	4,064	20,419	47,693	3,109	2,298	71,073	167.34	235,959
1972	W	4,369	20,504	53,293	4,284	1,152	70,312	177.47	244,183

See footnotes at end of table.

Table 2.—Tin statistics—Continued
(Metric tons)

Year	United States								World mine production [3]
	Production			Imports					
	Mine	Smelter	Secondary	Metal	Ore (tin content)	Exports and reexports	Consumption [1]	Price cents per pound [2]	
1973	W	4,877	20,806	46,581	4,875	3,461	75,838	227.56	237,847
1974	W	6,096	19,200	40,238	5,971	8,550	65,780	396.27	233,747
1975	W	6,500	15,856	44,366	6,415	3,596	55,800	339.82	225,195

W Withheld to avoid disclosing individual company confidential data.
[1] Apparent consumption from 1910 to 1936, inclusive.
[2] Source: Metals Week.
[3] Prior to 1925, world mine production figures are obtained from U.S.B.M. Economic Paper 13.

The only primary tin smelter-refinery operating in the United States in 1975 was the Texas City, Tex., facility of Gulf Chemical & Metallurgical Co. (GCMC). The major feed to the smelter was tin concentrate from Bolivia's State-owned Corporation Minera de Bolivia (COMIBOL).

In January, the ITC reacted to increased production costs by raising the floor and ceiling prices for tin by 6% and 5%, respectively. The average New York price for prompt delivery of Straits (Malaysian) tin in 1975 was 339.82 cents per pound, a significant decrease from the 1974 average of 396.27 cents per pound.

Legislation and Government Programs.—The General Services Administration (GSA) continued commercial sales of tin during the year but at a much lower level than during the previous 2 years. Sales for the year, all commercial, totaled 584 tons while shipments totaled 443 tons. At yearend there was an excess of 169,043 tons above the 41,150 ton objective, of which 6,347 tons was authorized for sale by Congress.

The Office of Minerals Exploration (OME), U.S. Geological Survey, continued its program of offering participatory loans for tin exploration up to 75% of approved costs. No contracts were let during the year.

The depletion allowance for tin remained at 22% for domestic deposits and 14% for foreign deposits.

DOMESTIC PRODUCTION

PRIMARY TIN

Mine Production.—Domestic production of tin in 1975 was less than 100 tons. Most of the year's output came from Colorado as a byproduct of molybdenum mining. Some tin concentrate was produced as a byproduct of gold dredging operations in Alaska and placer operations in New Mexico.

Smelter Production.—The only smelter in the United States is the Texas City, Tex., facility of GCMC. In 1975, GCMC received 6,415 tons of tin in concentrate from Bolivia which formed the base load, together with domestic tin concentrate and secondary tin-bearing materials. Tin production was estimated at 6,500 tons. GCMC continued to operate under a 10-year contract negotiated in 1973 with Bolivia under which Bolivia guaranteed to deliver 6,000 tons of tin in concentrate to GCMC in each of the first 3 years of the contract.

SECONDARY TIN

The United States is the world's largest producer of recycled, or secondary, tin. Secondary tin furnishes about 25% of the total U.S. supply each year. In 1975, secondary tin production declined 17% from the previous year's level to 15,856 tons. Of the tin recycled in 1975, 88% was an alloy constituent of reclaimed bronzes, brasses, solders, and bearing and type metals, or an element in chemical compounds. Only 12% of the recycled tin, mostly from new tinplate scrap, was reclaimed as metal. This latter volume provided only 3% of the total tin supplied to U.S. consumers in 1975, a proportion which does not vary appreciably from year to year.

Proler International Corp. started a new detinning plant at El Paso, Tex. The plant will reclaim about 300 tons of electrolytic tin annually from 100,000 tons of tinplate scrap. Proler also purchased two detinning plants from Vulcan Materials Co., one in Los Angeles and the other in Houston. The Los Angeles plant continued in operation while being modified to increase capacity and improve efficiency but the Houston plant was dismantled and will be modified and enlarged for re-erection at Copperton, Utah.

Metal Cleaning & Processing Inc., a subsidiary of Continental Can Co., began detinning operations at its Wilmington, Del., plant during the year. Unburned cans from municipal waste made up the majority of the plant feed.

Table 3.—Tin recovered from scrap processed in the United States, by form of recovery
(Metric tons)

Form of recovery	1974	1975
Tin metal:		
At detinning plants	1,805	1,689
At other plants	216	228
Total	2,021	1,917
Bronze and brass:		
From copper-base scrap	8,938	6,913
From lead- and tin-base scrap	25	42
Total	8,963	6,955
Solder	5,319	4,414
Type metal	987	877
Babbitt	570	569
Antimonial lead	729	442
Chemical compounds	599	670
Miscellaneous [1]	12	12
Total	8,216	6,984
Grand total	19,200	15,856
Value (thousands)	$167,738	$133,149

[1] Includes foil,cable lead, and terne metal.

Table 4.—Secondary tin recovered from scrap processed at detinning plants in the United States

	1974	1975
Tinplate scrap treated ... metric tons	717,766	614,667
Tin metal recovered in the form of:		
Metal ... do	1,449	1,146
Compounds (tin content) ... do	585	670
Total [1] ... do	2,034	1,816
Weight of tin compounds produced ... do	1,085	1,344
Average quantity of tin recovered per metric ton of tinplate scrap used ... kilograms	2.83	2.95
Average delivered cost of tinplate scrap ... per metric ton	$108.65	$65.59

[1] Recovery from tinplate scrap treated only. In addition, detinners recovered 368 metric tons (370 tons in 1974) of tin as metal and in compounds from tin-base scrap and residues in 1975.

Table 5.—Shipments of metal cans [1]

(Thousand base boxes)

Type of can	1974	1975 p	1975 change (percent)
FOOD AND BEVERAGES			
Fruit and fruit juices	14,547	13,235	−9.0
Vegetables and vegetable juices	25,581	24,490	−4.3
Dairy-based products	3,603	3,504	−2.7
Soft drinks	35,757	33,429	−6.5
Beer	53,072	52,759	−.6
Meat and poultry	3,555	3,191	−10.2
Fish and other seafoods	3,225	2,308	−28.4
Coffee	3,365	3,524	+4.7
Lard and shortening	1,912	2,017	+5.5
Baby foods	1,494	1,427	−4.5
Pet foods	7,083	6,022	−15.0
All other foods, including soups	15,814	14,422	−8.8
Total	169,008	160,328	−5.1
NONFOOD			
Oils	2,533	2,301	−9.2
Paint and varnish	5,192	5,328	+2.6
Pressure packing (valve type)	5,765	4,814	−16.5
All other nonfood	5,260	4,517	−14.1
Total	18,750	16,960	−9.5
Grand total	187,758	177,288	−5.6
BY METAL			
Steel base boxes [2]	148,030	133,835	−9.6
Short tons (thousand)	5,828	5,268	−9.6
Aluminum base boxes	39,728	43,453	+9.4

p Preliminary.
[1] Includes tinplate and aluminum cans.
[2] The base box, a unit commonly used in the tinplate industry, equals 31,360 square inches of plate or 62,720 square inches of total surface area.
Source: U.S. Department of Commerce.

Table 6.—Stocks, receipts, and consumption of new and old scrap and tin recovered in the United States, in 1975

(Metric tons)

Type of scrap and class of consumer	Gross weight of scrap						Tin recovered		
	Stocks Jan. 1	Receipts	Consumption New	Consumption Old	Consumption Total	Stocks Dec. 31	New	Old	Total
Copper-base scrap:									
Secondary smelters:									
Auto radiators (unsweated)	3,233	41,884	--	41,421	41,421	3,696	--	1,781	1,781
Brass, composition or red	3,792	45,692	10,165	34,538	44,703	4,781	386	1,272	1,658
Brass, low (silicon bronze)	492	2,177	1,552	561	2,113	556	--	3	3
Brass, yellow	4,711	34,997	4,371	30,708	35,079	4,629	10	307	317
Bronze	1,289	18,064	2,530	15,288	17,818	1,535	201	1,197	1,398
Low-grade scrap and residues	12,729	50,316	41,297	9,769	51,066	11,979	16	--	16
Nickel silver	753	2,488	299	2,228	2,527	714	3	16	19
Railroad-car boxes	208	1,069	--	983	983	294	--	47	47
Total	27,207	196,687	60,214	135,496	195,710	28,184	616	4,623	5,239
Brass mills: [1]									
Brass, low (silicon bronze)	4,487	25,716	25,716	--	25,716	3,932	--	--	--
Brass, yellow	20,249	190,472	190,472	--	190,472	21,669	160	--	160
Bronze	1,154	3,450	3,450	--	3,450	902	155	--	155
Nickel silver	6,450	35,591	35,591	--	35,591	6,558	--	--	--
Total	32,340	255,229	255,229	--	255,229	33,061	315	--	315

See footnotes at end of table.

Table 6.—Stocks, receipts, and consumption of new and old scrap and tin recovered in the United States, in 1975—Continued

(Metric tons)

Type of scrap and class of consumer	Gross weight of scrap						Tin recovered		
	Stocks Jan. 1	Receipts	Consumption: New	Consumption: Old	Consumption: Total	Stocks Dec. 31	New	Old	Total
Copper-base scrap—Continued									
Foundries and other plants:[2]									
Auto radiators (unsweated)	1,030	7,019	--	6,951	6,951	1,098	--	313	313
Brass, composition or red	798	3,918	1,381	2,875	4,256	460	66	137	203
Brass, low (silicon bronze)	51	563	292	289	581	33	--	4	4
Brass, yellow	676	5,371	1,907	3,665	5,572	475	--	14	14
Bronze	71	612	111	496	607	76	7	39	46
Low-grade scrap and residues	338	[3] 207	47	--	47	84	--	--	--
Nickel silver	--	9	--	9	9	--	--	--	--
Railroad-car boxes	252	4,449	--	4,160	4,160	541	--	198	198
Total	3,216	21,734	3,738	18,445	22,183	2,767	73	705	778
Total tin from copper-base scrap	XX	XX	XX	XX	XX	XX	1,004	5,328	6,332
Lead-base scrap: Smelters, refiners, and others:									
Babbitt	r 361	2,967	--	3,188	3,188	140	--	376	376
Battery lead plates	53,412	561,299	--	565,584	565,584	49,127	--	780	780
Drosses and residues	30,988	121,341	123,437	--	123,437	28,892	2,385	--	2,385
Solder and tinny lead	478	9,925	--	10,207	10,207	196	--	1,584	1,584
Type metal	2,655	17,492	--	17,980	17,980	2,167	--	809	809
Total	r 87,894	713,024	123,437	596,959	720,396	80,522	2,385	3,549	5,934
Tin-base scrap: Smelters, refiners, and others:									
Babbitt	18	176	--	167	167	27	--	141	141
Block-tin pipe	28	85	--	108	108	5	--	107	107
Drosses and residues	304	1,991	2,163	--	2,163	132	1,153	--	1,153
Pewter	2	4	--	6	6	--	--	5	5
Total	352	2,256	2,163	281	2,444	164	1,153	253	1,406
Tinplate and other scrap: Detinning plants	--	--	614,667	--	614,667	--	2,184	--	2,184
Grand total	XX	XX	XX	XX	XX	XX	6,726	9,130	15,856

r Revsied. XX Not applicable.

[1] Brass-mill stocks include home scrap, and purchased-scrap consumption is assumed equal to receipts; therefore, lines and total in brass-mill section do not balance.

[2] Omits "machine-shop scrap."

[3] Negative receipts indicate shipments greater than receipts.

CONSUMPTION

Tin consumption was at its lowest level since 1934. Primary and secondary consumption declined 17% and 9%, respectively, with total consumption of tin down 15% or 9,980 tons from that of 1974. Tin consumed in all end uses except white metal declined. The largest decreases were recorded in the consumption of tin in tinplate, down 3,817 tons; bronze and brass, 1,953 tons; and chemicals including tin oxide, 944 tons. Increased use of tin in the white metal category (including pewter, britannia metal, and jeweler's metal) was attributed to the manufacture of items for the United States bicentennial. U.S. brass mills consumed 481 tons of primary tin and 244 tons of secondary tin compared with the 1974 levels of 1,029 tons and 280 tons, respectively.

Table 7.—Consumption of primary and secondary tin in the United States
(Metric tons)

	1971	1972	1973	1974	1975
Stocks Jan. 1[1]	21,505	18,855	18,787	18,534	20,228
Net receipts during year:					
Primary	52,557	55,958	60,125	55,382	43,183
Secondary	2,531	2,842	4,089	2,285	2,699
Scrap	16,439	14,115	13,915	12,296	10,568
Total receipts	71,527	72,915	78,129	69,963	56,450
Total available	93,032	91,770	96,916	88,497	76,678
Tin consumed in manufactured products:					
Primary	52,814	54,360	59,075	52,439	43,620
Secondary	18,259	15,952	16,763	13,341	12,180
Total	71,073	70,312	75,838	65,780	55,800
Intercompany transactions in scrap	3,104	2,671	2,544	2,489	1,438
Total processed	74,177	72,983	78,382	62,269	57,238
Stocks Dec. 31 (total available less total processed)	18,855	18,787	18,534	20,228	19,440

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1971—10 tons; 1972—142 tons; 1973—986 tons; 1974—823 tons; and 1975—70 tons.

Table 8.—Tin content of tinplate produced in the United States

Year	Tinplate waste—waste, strips, cobbles, etc., gross weight (metric tons)	Tinplate (all forms)		
		Gross weight (metric tons)	Tin content[1] (metric tons)	Tin per metric ton of plate (kilograms)
1971	497,100	4,806,233	24,049	5.0
1972	455,403	4,269,658	21,408	5.0
1973	473,589	4,452,774	21,608	4.9
1974	399,947	4,701,835	22,686	4.8
1975	336,967	4,619,989	18,869	4.1

[1] Includes small tonnage of secondary tin and tin acquired in chemicals.

Table 9.—Consumption of tin in the United States, by finished products
(Metric tons of contained tin)

	1974			1975		
	Primary	Secondary	Total	Primary	Secondary	Total
Alloys (miscellaneous)	516	299	815	481	130	611
Babbitt	2,304	1,002	3,306	1,817	788	2,605
Bar tin	812	W	812	581	56	637
Bronze and brass	3,617	5,891	9,508	2,626	4,929	7,555
Chemicals including tin oxide	3,473	1,469	4,942	2,735	1,263	3,998
Collapsible tubes and foil	944	24	968	516	22	538
Solder	11,559	4,027	15,586	10,669	4,406	15,075
Terne metal	365	137	502	267	85	352
Tinning	2,517	46	2,563	1,879	17	1,896
Tinplate[1]	22,686	--	22,686	18,869	--	18,869
Tin powder	1,331	W	1,331	850	--	850
Type metal	120	224	344	76	189	265
White metal[2]	1,810	195	2,005	1,948	269	2,217
Other	385	27	412	306	26	332
Total	52,439	13,341	65,780	43,620	12,180	55,800

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Includes secondary pig tin and tin acquired in chemicals.
[2] Includes pewter, britannia metal, and jeweler's metal.

STOCKS

Yearend stocks of plant-held pig tin declined 19% from the corresponding period of 1974. Tinplate mills held 68% of the plant pig tin stocks at yearend. Plant stocks were highest in January at 9,967 tons but trended downward, ending the year at 7,407 tons. All stock sectors, except tin in process and jobber-importer stocks declined from the 1974 levels.

Table 10.—U.S. industry yearend tin stocks
(Metric tons)

	1971	1972	1973	1974	1975
Plant raw materials:					
Pig tin:					
Virgin	7,904	8,283	7,658	8,784	7,090
Secondary	259	258	343	312	317
In process [1]	10,692	10,246	10,533	11,132	12,033
Total	18,855	18,787	18,534	20,228	19,440
Additional pig tin:					
In transit in United States	142	452	986	823	70
Jobbers-importers	1,656	2,763	1,153	691	2,059
Afloat to United States	4,583	3,785	3,688	4,409	4,115
Total	6,381	7,000	5,827	5,923	6,244
Grand total	25,236	25,787	24,361	26,151	25,684

[1] Tin content, including scrap.

PRICES

The world-wide recession had a marked effect on tin prices. Decreased demand caused tin prices to dip into the lower sector of the ITC price range every month of the year. ITC buffer stock purchases supporting the market price were evident in at least 9 months of the year.

Average prices for the year declined substantially from the 1974 record levels. The average price for cash tin on the London Metal Exchange (LME) was £3090.82 per metric ton (311.49 cents per pound) compared with £3493.61 per metric ton (352.08 cents per pound) in 1974. The average Penang price for ex-works Straits tin was M$963.79 per picul[3] (300.99 cents per pound) compared with M$1,136.63 per picul (354.97 cents per pound) in 1974.

The Penang price for ex-works Straits tin began the year at M$910 per picul (284 cents per pound) and rose quickly to the year high of M$1,050 per picul (328 cents per pound) late in January. After the January 31 upward revision of the ITC price range, profit-taking actions caused the price to drop into the lower sector by mid-February, where it remained untll mid-July. Technical factors such as the strength of the U.S. dollar, weakness of sterling, and strong grain markets caused Penang prices to rise into the middle sector of the ITC price range through September. Lack of strong physical demand resulted in the continued decline in the Penang price for the remainder of the year. The yearend Penang price was M$959 per picul (299 cents per pound).

[3] One Malaysian dollar (M$) = US$0.4164; 1 picul = 133.33 pounds.

Table 11.—Monthly prices of Straits tin for delivery in New York
(Cents per pound)

Month	1974 High	1974 Low	1974 Average	1975 High	1975 Low	1975 Average
January	313.50	280.00	298.14	378.25	336.00	363.76
February	383.00	325.75	351.49	375.25	368.50	372.07
March	406.75	366.50	389.41	370.25	363.25	366.04
April	467.00	408.50	440.76	362.50	345.75	354.10
May	470.00	427.00	456.88	345.50	339.25	342.54
June	473.25	448.00	462.81	347.75	334.50	342.48
July	449.25	412.50	426.57	346.25	327.00	333.22
August	432.00	414.25	422.98	337.50	325.75	331.82
September	434.00	404.50	415.91	333.50	314.50	322.77
October	399.50	347.75	367.42	324.50	319.00	321.95
November	384.00	365.00	370.96	331.00	313.00	324.03
December	366.00	340.75	351.87	307.25	300.75	303.07
Average	473.25	280.00	396.27	378.25	300.75	339.82

Source: Metals Week.

FOREIGN TRADE

Exports of tin metal from the United States declined 58% from the abnormally high 1974 level.

U.S. imports of tin metal increased 10% as the tin supplied by GSA sales declined and consumers returned to foreign supply sources. Of the 44,366 tons of tin metal imported, Malaysia supplied 54%; Thailand, 17%; the People's Republic of China, 14%; and Indonesia, 10%. Imports of tin-in-concentrate, all from Bolivia and destined for the Texas City smelter, totaled 6,415 tons, up 7% over the 1974 level.

Small tonnages of secondary tin enter the United States as alloy constituents in recyclable solders or other alloys, or as tinplate or other scrap, dross, skimmings, and residues. These imports are reflected in consumption figures and account for the differences normally encountered between U.S. production and consumption of secondary tin. Imports and exports of tin in alloy such as babbit, solder, type metal, and bronze are shown in the Minerals Yearbook chapters on copper and lead. Ferrous scrap exports, including those of tinplate and terneplate scrap, are not classified separately.

Table 12.—U.S. exports and imports for consumption of tin, tinplate, and terneplate in various forms

Year	Ingots, pigs, and bars: Exports Quantity (metric tons)	Ingots, pigs, and bars: Exports Value (thousands)	Ingots, pigs, and bars: Reexports Quantity (metric tons)	Ingots, pigs, and bars: Reexports Value (thousands)	Tinplate and terneplate: Exports Quantity (metric tons)	Tinplate and terneplate: Exports Value (thousands)	Tinplate and terneplate: Imports Quantity (metric tons)	Tinplate and terneplate: Imports Value (thousands)	Tinplate circles, strips and cobble: Exports Quantity (metric tons)	Tinplate circles, strips and cobble: Exports Value (thousands)	Tinplate scrap: Imports Quantity (metric tons)	Tinplate scrap: Imports Value (thousands)
1973	2,581	$12,099	880	$3,236	360,081	$89,704	428,029	$105,961	21,909	$2,678	10,834	$384
1974	6,003	47,774	2,547	15,700	434,806	166,843	289,389	98,349	15,781	2,654	11,471	861
1975	1,444	10,457	2,152	15,531	232,052	105,870	370,508	170,191	2,574	437	11,138	786

Table 13.—U.S. imports for consumption and exports of miscellaneous tin, tin manufactures, and tin compounds

Year	Miscellaneous tin and manufactures: Imports: Tinfoil, tin powder, flitters, metallics, tin and manufactures, n.s.p.f.	Imports: Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f.		Exports: Tin scrap and other tin-bearing material, except tinplate scrap	Tin compounds (imports)	
	Value (thousands)	Quantity (metric tons)	Value (thousands)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1973	$6,956	1,302	$1,322	$3,262	156	$645
1974	9,331	1,789	1,186	5,950	189	1,316
1975	7,257	2,468	2,452	4,343	122	823

Table 14.—U.S. imports for consumption of tin, by country

Country	1974 Quantity (metric tons)	1974 Value (thousands)	1975 Quantity (metric tons)	1975 Value (thousands)
Concentrates (tin content): Bolivia	5,971	$35,999	6,415	$44,114
Metal:[1]				
Australia	402	2,487	325	2,176
Belgium-Luxembourg	10	92	--	--
Bolivia	1,153	8,571	149	1,185
Brazil	1,258	8,360	615	4,193
Canada	31	227	7	59
China, People's Republic of	3,336	9,396	6,378	39,761
Denmark	25	206	--	--
France	10	95	--	--
Germany, West	--	--	45	310
Hong Kong	25	209	200	170
Indonesia	4,186	30,340	4,371	29,823
Japan	205	1,692	31	203
Malaysia	21,000	164,154	23,920	177,359
Netherlands	197	1,737	--	--
Nigeria	529	4,521	59	454
Peru	--	--	145	1,520
Singapore	--	--	46	484
Switzerland	31	247	20	179
Taiwan	117	663	182	1,241
Thailand	5,859	41,500	7,422	50,290
United Kingdom	1,864	15,095	451	2,939
Total	40,238	289,592	44,366	312,346

[1] Bars, blocks, pigs, grain, or granulated.

WORLD REVIEW

INTERNATIONAL TIN AGREEMENT

Tin prices rose from the lowest sector to the ceiling of the ITC price range in the 3 weeks prior to the January 28 meeting of the ITC, allowing the producer nations to initiate an increase in the price range. The range was revised as follows:

	Previous range		Revised range	
	M$/picul	U.S. equivalent cents/pound	M$/picul	U.S. equivalent cents/pound
Floor price	850	265	900	281
Lower sector	850–940	265–294	900–980	281–306
Middle sector	940–1,010	294–315	980–1,040	306–325
Upper sector	1,010–1,050	315–328	1,040–1,100	325–344
Ceiling price	1,050	328	1,100	344

By the April meeting, tin prices had been in the lower sector of the price range for 2 months. The buffer stock had increased from 142 tons to over 5,000 tons. After reviewing market conditions, the ITC placed export controls on member producing nations starting April 18, amounting to about a 17% cutback from production levels of the corresponding period of 1974. Low demand continued forcing the ITC to maintain export controls for the remainder of the year. By December 31 the buffer stock held 20,071 tons.

Negotiations of the Fifth International Tin Agreement (ITA) to come into effect July 1, 1976, were completed during the year. The only substantial changes from the Fourth ITA were as follows: (1) The provision for the buffer stock to be enlarged from 20,000 tons to 40,000 tons through voluntary consumer nation contributions; (2) the provision for the renegotiation of the agreement after 30 months if consumer nation contributions to the buffer stock are not up to adequate levels; and (3) contributions to the buffer stock would be based on the then current floor price rather than the floor price at the beginning of the agreement.

On September 1, the United States announced its intent to join the Fifth ITA.

Table 15—Tin: World mine production by country [1]
(Metric tons)

Country	1973	1974	1975 p
North America:			
Canada	132	475	283
Mexico	292	400	457
United States	W	W	W
South America:			
Argentina	432	r[3] 590	e 600
Bolivia [2]	30,318	29,498	28,744
Brazil	r 5,444	5,387	e 5,400
Peru (recoverable)	r 233	155	e 150
Europe:			
Czechoslovakia	e[3] 158	148	e[3] 176
France	r 255	142	51
Germany, East e	1,120	1,120	1,120
Portugal	r 516	424	555
Spain	r 523	643	580
U.S.S.R. e	29,000	29,500	30,000
United Kingdom	3,783	3,827	e 3,900
Africa:			
Burundi e[3]	100	100	100
Cameroon	19	19	19
Morocco	15	4	--
Niger	r 91	79	90
Nigeria	5,828	5,455	4,652
Rhodesia, Southern e[3]	600	600	600
Rwanda e[3]	1,320	1,300	1,250
South Africa, Republic of	2,677	2,542	2,643
South-West Africa, Territory of	792	781	e 750
Swaziland e[3]	12	12	12

See footnotes at end of table.

Table 15.—Tin: World mine production by country [1]—Continued
(Metric tons)

Country	1973	1974	1975 p
Africa—Continued			
Tanzania	23	11	11
Uganda	44	199	e 3 117
Zaire	r 5,422	4,750	e 3 4,160
Zambia	e 3 24	11	e 10
Asia:			
Burma	611	576	545
China, People's Republic of e	20,000	20,000	22,000
Indonesia	22,297	25,021	24,391
Japan	r 811	548	655
Korea, Republic of	8	14	4
Laos	748	594	522
Malaysia	72,262	68,124	64,364
Thailand	20,921	20,339	16,406
Vietnam, North e	200	250	250
Oceania: Australia	r 10,801	10,114	9,678
Total	r 237,847	233,747	225,195

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.
1 Data derived in part from the Statistical Bulletin of the International Tin Council, London, England.
2 Total of COMIBOL output, COMIBOL purchases from lessees operating in COMIBOL mines, and medium and small mines' sales to ENAF plus their exports.
3 Estimate by International Tin Council.

Table 16.—Tin: World smelter production by country [1]
(Metric tons)

Country	1973	1974	1975
North America:			
Mexico e 2 3	960	1,200	1,000
United States 4	4,877	6,096	6,500
South America:			
Argentina e	120	120	120
Bolivia 5	r 7,038	6,907	7,133
Brazil	3,815	e 2 4,850	e 2 5,400
Europe:			
Belgium	3,669	3,418	4,562
Czechoslovakia	90	120	e 2 108
Germany, East e	1,120	1,120	1,120
Germany, West	1,038	1,384	1,306
Portugal	524	450	409
Spain	4,258	6,160	8,042
U.S.S.R. e	29,000	29,500	30,000
United Kingdom	r 20,404	11,818	11,520
Africa:			
Morocco e 2	12	12	12
Nigeria	5,983	5,574	4,677
Rhodesia, Southern e 2	600	600	600
South Africa, Republic of	874	854	780
Zaire	969	627	575
Asia:			
China, People's Republic of e	20,000	20,000	22,000
Indonesia	14,632	15,066	17,825
Japan	r 1,441	1,328	1,212
Malaysia 6	82,469	84,396	83,070
Thailand	22,927	19,827	16,630
Vietnam, North e	150	200	200
Oceania: Australia	6,904	6,714	5,254
Total	r 233,874	228,341	230,055

e Estimate. p Preliminary. r Revised.
1 Data derived in part from the Statistical Bulletin of the International Tin Council, London, England.
2 Estimate by the International Tin Council.
3 Smelter output from domestic ores was as follows in metric tons: 1973-292; 1974-400; 1975-457.
4 Includes tin content of alloys made directly from ores.
5 Tin content of production from Metabol and Pero smelters plus exports by ENAF smelter.
6 Includes small production of tin from smelter in Singapore.

Australia.—Australia's tin production continued to decline for the third consecutive year, reaching 9,678 tons, the lowest level since 1970. All tin production came from four States, with Tasmania the largest producer, followed by New South Wales, Queensland, and Western Australia.

Renison Ltd., Australia's largest tin producer, recorded a slight decline in production for the fiscal year ended June 30. The company treated 452,408 tons of ore at an average grade of 1.25%, recovering 3,889 tons of tin-in-concentrate. During the last half of 1975, export restrictions caused cuts of 25% and 29%, respectively, in concentrate production and sales. The heavy-media separation plant was closed in December until the market situation improved. The joint venture between Renison, the Aberfoyle group, and Consolidated Gold Fields, Australia, Ltd., started diamond drilling at the Mount Lindsay prospect near Renison in Tasmania.

Diamond drilling was suspended at the Gillian prospect near Mount Garnet in northeast Queensland while metallurgical research was carried out. The joint venture between Renison and Otter Exploration, Ltd., has delineated significant areas containing 0.7% tin but treatment may be difficult.

Aberfoyle Ltd., Ardlethan Tin N.L., and Cleveland Tin N.L., all of the Aberfoyle group, produced 185 tons, 1,311 tons, and 1,370 tons, respectively, all at least 10% below the respective 1974 levels, as ITC controls forced cutbacks to 60% capacity. Operations were reduced to 5 days per week. Cleveland Tin's indicated ore reserves as of October 1 were 1.9 million tons grading 0.82% tin and 0.32% copper. Ardlethan Tin reserves on the same date were 2 million tons grading 0.56% tin.

Greenbushes Tin N.L. received permission to divert a highway through the center of its operations, thus providing an additional 5 years of reserves. Greenbushes also obtained a 3-year license to mine Vultan Minerals Ltd.'s neighboring leases. Vultan and Greenbushes leases covered the largest tinfield in Western Australia.

Bolivia.—Tin production, at 28,744 tons, was only slightly below the 1974 level. COMIBOL produced 20,965 tons, 6% above that of 1974. However, the medium and small miners' production, at 6,056 and 1,723 tons, respectively, declined 5% and 46% from the 1974 levels. Total tin exports were down 9% from 1974 levels to 26,440 tons but Empresa Nacional de Fundiciones (ENAF), the national smelting company, increased metal exports from 7,049 tons in 1974 to 7,497 tons in 1975.

The declining ratio of concentrate exports to metal exports will continue as expansion of Bolivia's smelting capacity progresses. The Vinto smelter capacity reached 11,000 tons per year late in 1975. One more plant expansion, to a total capacity of 20,000 tons per year, was projected to be completed by late 1978.

A low-grade smelter will be built near the Vinto complex and was scheduled to start up in 1978 with an initial capacity of 5,000 tons per year, reaching 12,500 tons by 1980. The smelter, featuring three vacuum distillation plants, will be built by Klöckner Industrieanlagen AG and Paul Bergse & Son A/S. Part of the feed for the lowgrade smelter will be supplied by the Soviet-built 400-ton-per-year tin volatilization plant under construction at Potosí. Two more tin volatilization plants were planned for the Machacamarca area. A $1.75 million, 1,500 ton-per-day preconcentration plant started up at Pailaviri as part of the metallurgical complex to feed the low-grade smelter.

The Huanuni mine tin ore processing capacity has increased from 1,080 to 1,200 tons per day with the opening of a new crushing plant.

Bolivian mining costs were reported to be between $3.00 to $3.20 per pound at yearend.

Brazil.—The Brazilian Government approved a $5.3 billion nonferrous metals development program striving to make Brazil self-sufficient by 1983. Domestic production of tin in 1988 was projected at 21,000 tons. The government planned liberal credit extensions to private industry to facilitate the expansion.

An airborne geophysical survey covering 350,000 square kilometers of central Brazil began in midyear. Tin and other nonferrous metals were the subject to the $8 million survey. Promising areas will be made available to private companies for mining.

Bera do Brasil S.A. will close most of its 340-ton-per-year tin smelter in São Paulo because it cannot meet the stringent pollution requirements of the area. The smelting of tin, lead, and their alloys will be moved to a new location outside São Paulo.

Indonesia.—The expansion of the Mentok tin smelter was completed with the addition of three reverberatory furnaces. The capacity was increased from 18,000 to 33,000 tons. Exports of tin concentrate to Malaysia will cease after February 1976 and Indonesia's total tin output will be smelted in the country.

Several offshore discoveries were reported during the year. After 7 years of exploration in its two offshore concessions, N.V. Billiton Maatschappij announced the discovery of a deposit in the area of Pulau Tudju containing "tens of thousands" of tons of tin ore. Billiton planned to begin dredging the deposits in 1978 at the rate of 2,430 tons per year of 70% tin ore.

A 5-year survey by P.N. Timah and Fugro-Cesco BV of a 33,000-square-kilometer offshore area has located a 50-square-kilometer area of new tin reserves near the Riau Archipelago. No reserve figure was made public but the deposit thickness average 20 meters.

The first stage of development of the Kelapa Kampit lode mine on Bilitung Island was completed by P.T. Broken Hill Pty. Indonesia (BHP). The mine was dewatered to the 135-meter fourth level. Most of the shaft timbers were well preserved. First production from the HS2 shaft was expected early in 1976. Two separate workings, one an old Netherlands working and the other a BHP discovery, provided about 100 tons of ore for processing at the pilot mill. Delineation of the ore bodies and determination of production costs were prerequisites to determining if Kelapa Kampit reaches actual production.

Malaysia.—Although tin production declined to its lowest level in 11 years because of export controls, Malaysia continued to lead the world in the production, smelting, and exports of tin in 1975. A total of 64,364 tons of tin was mined, 6% below the 1974 level. At yearend there were 55 tin dredges, 810 gravel pump mines, and 45 opencast, underground, and other miscellaneous mines in operation, reflecting an 11% decrease in total active mines from yearend 1974 levels. Gravel pump operations accounted for 55% of the concentrate produced; dredging, 32%; opencast mining, 4%; underground mining, 3%; and miscellaneous sources, 6%. The tin mining labor force declined 10% to 39,736 workers at yearend.

Metal production, at 83,070 tons was 2% below the 1974 level. Exports of metal decreased to 77,635 tons from 85,229 tons in 1974. Imports of tin in concentrate totaled 18,358 tons, up 35% from those of 1974, but were expected to fall in 1976 after Indonesia ceases to export tin concentrate.

Industry officials continued to warn of problems that reduced prospecting activity to a standstill and created a poor investment climate. Heavy taxation was a substantial deterrent. The tin industry, the heaviest taxed industry in Malaysia, paid export duties, export surcharges, and tin profits, development, and income taxes. Also, delays in processing applications for mining leases and the possible rejection of lease renewal applications have been major contributors to declining production over the past 3 years. Streamlining the application process and reduced taxation have been recommended.

The Geological Survey of Malaysia, in a study of Malaysia's mineral resources, recommended special tax incentives to encourage the exploration of tin lodes. "If the mining industry is to maintain its present important position in the national economy, top priority must be given to the study of tin lodes. This is necessary in view of the fact that the known alluvial tin fields are suffering gradual depletion and it is unlikely that any large new ones will be found to replace them," the report stated.

Export controls and low prices caused closure of 94 gravel pump mines between the end of April and the end of December. A hardship quota pool was established by the Malaysian Government to assist marginal miners in meeting operating costs during the period of export restrictions. Additional production was allowed to qualifying mines to permit production at levels matching operating costs. The pool was not intended to assist mines to operate at a level better than survival level or to give assistance to mines suffering economic hardship caused by factors other than production controls.

Through various complicated stock transactions, Perbadanan Nasional Bhd.'s (Pernas) subsidiary, Pernas Securities (the Malaysian Government investment branch) and Haw Par Brothers International (HPBI) made an effort to obtain majority ownership of London Tin Corp. Ltd. (LTC), the world's largest tin investment group and the largest holder of Malaysian tin mines. The London Takeover Panel required HPBI and Pernas to make a full-scale bid for the remaining 49.7% of the LTC shares not already under their control. HPBI financial problems precluded finalization of the deal and Pernas was seeking another method to attain control in LTC, furthering the Malaysian Government's goal of 70%-domestic private ownership in the tin industry by 1990.

LTC's Malaysian mine holdings consist of Austral Amalgamated Tin Bhd., 14.4%; Berjuntai Tin Dredging Bhd., 37.4%; Kampong Lanjut Tin Dredging Bhd., 34.8%; Kamunting Tin Dredging Ltd., 23.8%; Kramat Tin Dredging Bhd., 30.9%; Kuala Kampar Tin Fields Bhd., 29.3%; Lower Perak Tin Dredging Bhd., 43.2%; Malayan Tin Dredging, Ltd., 39.2%; Southern Kinta Consolidated, Ltd., 31.8%; and Southern Malayan Tin Dredging Ltd., 11.4%. During the fiscal year ended March 31, 1976, total tin concentrate production (including output of companies in Thailand) totaled 16,749 tons compared with 19,806 tons in the previous year. At yearend, the Malaysian companies operated 30 bucket dredges. Two Malaysian based dredges, one owned by Kampong Lanjut and the other by Southern Kinta, were shut down during the year after exhausting the ore reserves. In addition to the dredge closures, reduction in the grade of deposits from about 0.15 kilogram per cubic meter to 0.12 kilogram per cubic meter was a factor in reduced production. Export controls had only a minimal effect on Malaysian mining operations, causing several dredges to reduce operating hours.

Berjuntai Tin Dredging Bhd. continued to be Malaysia's largest tin producing company although output decreased 14% from that of 1974 to 3,893 tons in 1975. The company operates a seven-dredge fleet but the two newest dredges, No. 6 commissioned in 1965 and No. 7 commissioned in 1971, produced more than half the total output. Construction continued satisfactorily on Berjuntai's $7 million No. 8 dredge. The 459,000-cubic-meter-per-month dredge, equipped with 0.6-cubic-meter buckets, will replace Berjuntai's No. 1 dredge when it begins operation July 1976.

Kuala Kampar Tin Fields Bhd., which operates two dredges in the Kinta district of Perak, entered into an option agreement with Boustead Ltd. for the purchase of 113 hectares of tin-bearing land at Trong. Perak. Ore reserves were estimated at 24 million cubic meters containing 0.16 kilogram per cubic meter recoverable tin concentrate.

The pontoon for the first dredge of Selangor State Development Corp's mining subsidiary, Syarikat Timnah Langat Sdn. Bhd., was launched early in 1975. The dredge will be the first of at least three to work the Ulu Langat district. The dredge was expected to be in operation in 1977, working a 690-hectare area in Dengkil and producing about 60 tons of tin ore per month. The Ulu Langat district was expected to become one of the largest tin mining areas in Selangor in the future.

Charter Consolidated Ltd., whose Malaysian tin holdings include a 39.2% interest in Bidor Malaya Tin Bhd., a 29.7% interest in Tronoh Mines Ltd., a 16.4% interest in Ayer Hitam Tin Dredging Ltd., and a 6.3% interest in Sungei Besi Mines Ltd., announced a feasibility study covering an area of deep tinbearing deposits in southern Selangor. Charter (36%), Tronoh (9%), and the Selangor State Development Corp. (55%) had a joint venture agreement on the area. Studies in the design of dredges and stripping equipment to work the reserves were commenced after prospecting and evaluation of the area during the year.

Although Pacific Tin Consolidated Corp., the only U.S. company mining tin in Malaysia, increased tin output in 1975 by 4% over that of 1974, operating revenues declined 9% as the price received per kilogram of tin declined from $7.63 to $6.66.

Bethlehem Steel Corp. has withdrawn from Conzinc Riotinto Malaysia, a joint tin mining venture in which Bethlehem held a 45% interest. The company operated a dredge at Labohan Dagang, Selangor.

Nigeria.—Tin production continued to decline for the seventh consecutive year to 4,652 tons in 1975, the lowest level since 1933. Increased mining costs, including fuel, power, and labor, continued to plague the Nigerian tin industry.

Amalgamated Tin Mines of Nigeria (Holdings) Ltd. (ATMN), Nigeria's largest tin mining company, received the first of two bucket wheel excavators during the year. Successful field trials at ATMN's Sabon Gida tinfield were reported. Because of Nigeria's port congestion, the second excavator and a 2.7-kilometer conveyor system were not shipped until October. Both excavators will work 50-meter-deep tin deposits in the Sabon Gida area. The excavators will be used in conjunction with draglines to strip the overburden and send it by conveyor for dumping in old mine workings about a kilometer away. The system was expected to be operational in mid-1976.

South Africa, Republic of.—The two major South African producers, Rooiberg Minerals Development Co. Ltd. and Union Tin Mines Ltd., increased tin concentrate output during 1975 to 3,686 tons (2,933 tons in 1974) and 1,593 tons (1,217 tons), respectively. The average grade of Rooiberg's gravity concentrates decreased from 63.94% to 63.43%, and flotation concentrates decreased from 28.11% to 24.10% for the year ended June 1975. The Vellefontein mine was opened with the sinking of a new inclined shaft.

Union Tin's increase in production was accompanied by sharply higher operating costs. Ore reserves were limited with little probability of additional discoveries. The tailings dump, where retreatment supplied the majority of Union Tin's production, was rapidly decreasing. Highgrading the mine and decreased exploration were expected to optimize profits during the remaining 2-year life of the mine.

Thailand.—Developing the mining sector as a means of promoting economic growth was made one of the objectives of Thailand's 1972–76 5-year plan. Prior to 1975, the Thai Government liberalized its attitudes towards foreign investment in mining and the duration and size of concessions. In 1975, the investment situation changed.

On March 17, after about 4 months of rising public pressure, the Thai Government withdrew the mining concessions of Thailand Exploration and Mining Co., Ltd. (Temco), the Union Carbide Corp. (46%), N.V. Billiton Maatschappij (46%), and Thai Government (8%) joint venture, charging that Temco had failed to comply with Government regulations. Temco was responsible for 9% of Thailand's 1974 output. Later in the year, the Thai Government failed to renew five of seven mining leases of Southern Kinta Consolidated Ltd. Both of these companies had planned additional investments in offshore tin mining. Temco had considered adding a $20 million dredge to its fleet and Southern Kinta was to add an additional dredge and other investments totaling $23 million. These plans were cancelled.

Thailand's onshore tin reserves continue to be depleted as reflected in Thailand's declining tin production over the past 3 years. To maintain its production levels, offshore deposits must be exploited.

By yearend, some problems had been resolved. Union Carbide had sold its share in Temco to Billiton. A new Government mining body, the Offshore Mining Organization, had agreed to contract with the newly Thai-registered Billiton company, Billiton Thailand Co., to mine Tempco's former concessions.

Illegal mining of offshore areas became a problem of visible proportion for the Thai Government in 1975. It appeared that Thai tin concentrates were being claimed to be of Burmese origin. An indication of the magnitude of the problem was that Malaysia imported 4,942 tons of tin-in-concentrate from Burma in 1975 compared with 528 tons in 1974. Burma's production for 1975, at 600 tons, was the same as in 1974.

Pacific Tin Consolidated Corp., which holds a 49% interest in Sierra Mining Co., Ltd., announced completion of a feasibility study at Sierra's tin dredging property near Sichon in southern Thailand. The study indicated that dredging would be profitable but mining would not commence until Government approval of certain leases. Two dredges were being considered to mine the property, one from a wholly-owned subsidiary of Pacific Tin in California, the other, Pacific Tin's No. 5 dredge in the Ampang area of Malaysia, which has been shut down since early 1975 after exhaustion of reserves.

United Kingdom.—Despite lower ore grades and recovery difficulties, there were moderate increases in mine production for 1975. Increased costs and low tin prices caused several mines to operate at a loss. Despite these financial problems, the mining companies continued development.

The Mount Wellington mine of Cornwall Tin & Mining Corp. continued development with an anticipated production date of early 1976. The mill will have a 200,000-ton-per-year concentrator that will recover about 1,600 tons of tin in concentrate per year.

Geevor Tin Mines Ltd. started deepening the Victory shaft and sinking a subincline to give access to the seaward extension of the Geevor lodes. Geevor also continued to develop four other lodes with encouraging results.

Marine Mining (Cornwall) Ltd. was granted permission to work the offshore alluvial tin deposits in St. Ives Bay and in the St. Agnes region. Commercial dredging operations were scheduled for late 1976.

Amalgamated Metal Corp. (AMC) and Consolidated Tin Smelters Ltd. (CTS) merged during the year, leaving AMC the dominant company. Patiño, N.V., had a controlling 50.2% interest in the new company. AMC's smelting interests include a 50.5% holding in Malaysia's Datuk Keramat Smelting Sdn. Bhd., 79% in Nigeria's Makeri Smelting Co., and 33.3% in Australia's Associated Tin Smelters Pty. Ltd.

Williams, Harvey & Co., Ltd., a CTS subsidiary placed in voluntary liquidation June 8, 1973, continued to operate on stocks of slags and residues. All creditors were paid and the company has contributed to AMC's profits. Some primary materials were treated to improve technical operations.

TECHNOLOGY

The three main problem areas that have developed in designing large capacity dredges are as follows: (1) The bucket chain; (2) the ore treatment plant; and (3) the tailings disposal. Efforts to resolve them were discussed by IHC Holland mining engineers.[4]

Continued research on froth flotation of cassiterite yielded several patentable processes.[5] Methods for roasting [6] and volatilizing [7] tin ores were patented.

A means of fabricating columbium-tin superconducting cable was developed jointly by Intermagnetics General Corp. and General Electric Co.[8] Previously, the use of columbium-tin alloys had been limited because of brittleness. Superconductors are required to develop major new sources of energy.

Several petroleum companies were granted patents for platinum-tin catalysts used in hydrocarbon refining.[9] Tin contents of the catalysts vary from 0.01% to 5%.

A new class of organotin stabilizer for polyvinyl chloride (PVC) was developed in the U.K.[10] The stabilizers were claimed to impart excellent heat stability and low odor to the PVC. Additionally, low volatility during processing improved safety for workers.

The range of actual and potential uses for the tin oxide-antimony oxide system was reviewed.[11] Applications include areas as diverse as glass melting, ceramic glaze pigmenting, electrically conductive glass manufacturing, industrial organic compound synthesis, and ion exchange mediums for the nuclear energy field.

After enactment of legislation prohibiting sale of flammable carpets in the United States, tin-based flame retardants have been used in limited applications to enable sheepskin rugs to pass the flammability tests.[12] The tin compounds have economic and technical advantages in applications where the flame retardant can be applied by spraying the tips of the wool pile.

A U.S. firm introduced terne-coated stainless steel.[13] A.I.S.I. Type 304 stainless steel is coated on both sides with a lead-20% tin terne alloy. Its advantages were claimed to be extremely long life, solderability, and formability. The terne coated stainless steel is particularly well suited for roofing.

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[4] Tin International. Large Capacity Dredge Design. V. 48, 1975, pp. 202, 398, 436.

[5] Griffith, R.M., and C. Parkinson (assigned to Allied Colloids Ltd.). Froth Flotation Beneficiation of Cassiterite. U.S. Pat. 3,929,629, Dec. 30, 1975.

Petrovich, V. Froth Flotation Beneficiation of an Oxide Ore of Tin, Manganese, Tungsten, Vanadium, Titanium or Thorium. U.S. Pat. 3,930,997, Jan. 6, 1976.

[6] Jensfelt, T.E., and K.G. Corling (assigned to Boliden A.B.). Roasting of Low-Grade Oxidic or Sulfidic Tin Ore, Particularly Pyritic Ore. U.S. Pat. 3,864,121, Feb. 4, 1975.

[7] Brovkin, V.G., B.F. Verner, V.V. Kostelov, B.P. Derevensky, V.N. Kostin, and S.N. Suturin (assigned to Proektny i Vauchno - Issledovatelsky Institut "Gipronikel.") British Pat. 1,391,572, Apr. 23, 1975.

[8] Metal Progress. Cb-Sn Superconductors Break "Brittleness Barrier." V. 108, No. 4, September 1975, p. 7.

[9] Tin International. Platinum-Tin Oil Catalysts. V. 48, 1975, p. 348.

Tin International.---And Tin Chemicals. V. 49, 1976, p. 52.

[10] Dean, R.R. A New Type of Organotin Stabilizer for PVC. Tin and Its Uses. Quart. Rev. Tin Res. Inst., No. 107, 1976, pp. 1–2.

[11] Fuller, M.J. The Versatile Mixed Tin Oxide Antimony Oxide System. Tin and Its Uses. Quart. Rev. Tin Res. Inst., No. 106, 1975, pp. 5–6.

[12] Ingham, P.E. Tin-Based Flame-Retardants for Wool. Tin and Its Uses. Quart. Rev. Tin Res. Inst., No. 105, 1975, pp. 5–6.

[13] MacKay, C.A., and C.J. Evans. Terneplate Today. Tin and Its Uses. Quart. Rev. Tin Res. Inst., No. 105, 1975, p. 3.

Titanium

By F. W. Wessel [1]

Production of both sponge and ingot titanium declined throughout the year, although ingot production seemed to have bottomed out by yearend. Sponge inventories climbed from 3,822 tons to 5,689 tons, 60% in the hands of producers, at yearend. Demand for pigment continued its 1974 decline through March, but strengthened during the spring and summer.

Ilmenite production and imports of natural rutile declined 4% and 14%, respectively, but imports of ilmenite and of synthetic rutile increased 48% and 12%, respectively.

Except for rutile, prices were generally higher than in 1974. Effective prices for rutile were about $350 per metric ton f.o.b. Australian mines at yearend. The price of domestic sponge increased 10% in August, and pigment prices advanced 9% in the same month.

Table 1.—Salient titanium statistics

	1971	1972	1973	1974	1975
United States:					
Ilmenite concentrate:					
Mine shipments __ short tons __	713,610	r 739,801	r 804,355	r 755,338	702,252
Value __________ thousands __	$15,936	r $16,739	r $20,128	$22,715	$26,946
Imports ________ short tons __	28,093	14,836	r 69,641	82,448	122,010
Consumption ________ do ____	898,783	786,384	807,733	851,977	747,821
Titanium slag:					
Imports ____________ do ____	152,661	298,259	237,248	236,272	212,682
Consumption ________ do ____	143,554	264,095	281,791	257,125	147,965
Rutile concentrate, natural and synthetic:					
Imports ____________ do ____	227,784	220,533	r 226,860	r 246,489	224,499
Consumption ________ do ____	225,498	242,758	276,907	292,661	231,427
Sponge metal:					
Imports for consumption _______ do ____	2,802	3,808	5,172	6,963	4,190
Consumption ________ do ____	12,145	13,068	20,173	26,896	17,626
Price: December 31, per pound ________________	$1.32	$1.32	$1.42	$2.25	$2.70
World production:					
Ilmenite concentrate short tons __	2,845,789	2,702,398	r 2,983,123	r 3,098,708	2,854,436
Titanium slag __________ do ____	859,097	924,084	947,394	r 936,023	831,502
Rutile concentrate, natural ______________ do ____	423,825	351,380	r 385,284	r 365,078	[1] 386,582

r Revised.

[1] Excludes United States production data in order to avoid disclosing company confidential data.

Legislation and Government Programs.—In June, the General Services Administration (GSA) offered 1 million pounds of titanium sponge from the stockpile. No acceptable bids were received.

The Environmental Protection Agency (EPA), noting the absence of opposing opinion, amended 86 Stat. 816, Pub. L. 92–500 (33 U.S.C. 1215, 1311, 1314 (b), 1361 (a)), 40 CFR, Chapter I, Subchapter N, Section 415.220 of the Federal Water Pollution Control Act to read as follows: "The provisions of this subpart are applicable to discharges resulting from

[1] Physical scientist, Division of Nonferrous Metals.

the production of titanium dioxide by the sulfate process and by the chloride process. The provisions of this subpart are not applicable to the wastes resulting from discharges from production by processes in which beneficiation of raw ilmenite ore and chlorination are inseparably combined in the same process step."[2]

DOMESTIC PRODUCTION

Concentrates.—Production and shipments of ilmenite concentrate decreased 4% and 7%, respectively, the second consecutive decline for both categories. Titanium dioxide contained in concentrates shipped was 7% less than in 1974; TiO_2 content increased fractionally to 57.6%. The 150% increase in production at the Titanium Enterprises mine, Green Cove Springs, Fla., and the 60% increase in production by Humphreys Mining Co., was insufficient to offset decreases of 4% to 21% at the mines of NL Industries, Inc., Tahawus, N.Y.; E. I. du Pont de Nemours & Co., Inc., Starke and Highland, Fla.; and ASARCO, Inc. and SCM Corp., Glidden-Durkee Div., both near Lakehurst, N.J. The Humphreys Mining Co. production was the result of nearly a full year of operation at Boulogne, Fla.; the 1974 total represented the last 6 months of mining at Folkston, Ga., before moving the mining equipment.

In September, Ethyl Corp. purchased 572 acres of land near its heavy-sand deposit in Henry County, Tenn. At about the same time, the company concluded its feasibility study. Plans for construction and operation were recessed pending revival of the titanium market.

Table 2.—Production and mine shipments of ilmenite concentrates[1] from domestic ores in the United States

Year	Production (short tons, gross weight)	Shipments: Short tons (gross weight)	Shipments: TiO_2 content (short tons)	Shipments: Value (thousands)
1971	683,075	713,610	388,802	$15,936
1972	r 677,944	r 739,801	r 417,553	r 16,739
1973	r 776,013	r 804,355	r 458,541	r 20,128
1974	r 744,571	r 755,338	r 434,605	22,715
1975	717,281	702,252	404,269	26,946

r Revised.
[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite.

Ferroalloys.—Shieldalloy Corp. at Newfield, N.J., continued as the sole producer of ferrotitanium in the country; as before, most of the production was in the titanium content range of 40% or higher. Foote Mineral Co. continued to produce Grainal alloys, which contain minor quantities of titanium.

Metal.—Production of titanium sponge decreased gradually during 1975; the year's production was 5% less than in 1974, although still greater than the 1973 production. However, even though imports were 40% less in 1975, yearend inventories were 48% greater than at yearend 1974. Ingot production declined 29% during the year.

Sponge producing companies were Titanium Metals Corp. of America (TMCA), Henderson, Nev., owned by NL Industries, Inc. and Allegheny-Ludlum Steel Corp.; and RMI Co., Ashtabula, Ohio, owned by National Distillers & Chemical Corp. and United States Steel Corp. As in previous years, the following nine companies produced ingot:

[2] Federal Register. V. 40, No. 26, Feb. 6, 1975, p. 5523.

Company	Plant location
Crucible Steel Co. of America	Midland, Pa.
Howmet Corp	Whitehall, Mich.
Martin Marietta Aluminum, Inc	Torrance, Calif.
Oregon Metallurgical Corp	Albany, Oreg.
RMI Co	Niles, Ohio
Teledyne Titanium, Inc	Monroe, N.C.
Titanium Metals Corp. of America	Henderson, Nev.
Titanium West, Inc	Reno, Nev.
TiTech International, Inc	Pomona, Calif.

Table 3.—Titanium metal data
(Short tons)

	1971	1972	1973	1974	1975
Sponge metal:					
Imports for consumption	2,802	3,808	5,172	6,963	4,190
Industry stocks	2,724	1,816	1,941	3,822	5,669
Government stocks (DPA inventories) [1]	19,994	19,994	18,706	11,897	10,810
Consumption	12,145	13,068	20,173	26,896	17,626
Scrap metal consumption	6,149	7,802	10,038	10,599	8,316
Ingot: [2]					
Production	18,387	20,267	28,932	36,132	25,560
Consumption	17,058	19,499	25,409	31,563	24,486
Net shipments of mill products [3]	11,241	12,627	14,530	17,443	15,628

[1] As of June 30 each year.
[2] Includes alloy constituents.
[3] Bureau of Census, Current Industrial Reports Series DIB–991.

New orders for mill products began to slow as early as February, and stretchouts and a few cancellations appeared. Consumers' inventories of mill products seemed to be the major cause of the slump. This was the case principally in the aircraft field; nonaerospace demand was holding up well.

In June, TMCA announced plans for a 20% increase in melting capacity and a pilot cell for experimental electrolytic titanium production, both at Henderson, and doubled capacity for production of welded tubing at Toronto, Ohio.

Pigment.—Pigment production was 23% less than in 1974. Shipments were down 24%, and value of shipments decreased 20%. Rutile pigment accounted for 79% of total production and was produced by all seven manufacturers. Five companies produced anatase pigment.

At Edge Moor, Del., E. I. du Pont de Nemours & Co., Inc., phased out its last sulfate process unit in December 1974; the 80,000-ton-per-year chloride-process unit, built as a replacement, began production in January 1975. Du Pont's capacity for pigment at Edge Moor is now 160,000 tons per year. The company is barging plant effluent to sea as a temporary disposal measure, while developing alternate treatment methods. A facility for

Table 4.—Titanium pigment data
(TiO_2 content)

Year	Production (short tons)	Shipments [1]	
		Quantity (short tons)	Value, f.o.b. (thousands)
1971	677,751	684,698	$311,140
1972	r 693,281	r 725,059	r 346,624
1973	784,996	793,991	404,639
1974	787,646	759,068	513,409
1975	p 603,429	p 580,139	p 409,836

p Preliminary. r Revised.
[1] Includes interplant transfers.

Source: Bureau of the Census.

separating ferric chloride from the pigment plant effluent was already in operation. Ferric chloride is useful in water purification, but a demand for 250,000 tons per year would be needed to eliminate 75% of the ocean dumping. The company was also testing a process more or less parallel to recent work done by the Bureau of Mines, in which waste chlorides are oxidized, leaving a high iron content solid and permitting the recycle of chlorine.

One of the two chloride-process units at Edge Moor was closed for 20 days during the year to find and repair a major leak. Loss of production was estimated at 3,500 tons of product.

Du Pont was reported in April to have decided to proceed with construction of a chloride-process plant of 130,000-ton-per-year capacity at DeLisle, Miss. The target date for completion is in the second half of 1978. NL Industries closed its Sayreville, N.J., sulfate-process plant for about 6 weeks to reduce inventories. American Cyanamid Co. closed two of its three units in Savannah, Ga., during January for the same purpose.

The effluent treatment plant of American Cyanamid Co. began operations in 1975. Three acid rejects, at 20% sulfuric acid, pH 0.5, and pH 4, respectively, are treated with limestone and slaked lime. Carbon dioxide evolves and is collected and sold; gypsum is precipitated and filtered out, and the remaining impurities precipitated by pH adjustment as metal hydroxides. The gypsum is of high enough purity to be salable. Cyanamid estimates a cost of $60 to $80 per ton of pigment for effluent treatment.

Construction of Kerr-McGee Chemical Co.'s synthetic rutile facility at Mobile, Ala., continued during the year. When complete, its output is estimated at 110,000 tons per year. As soon as production from this plant makes it possible, Kerr-McGee's pigment plant at Hamilton, Miss., will use synthetic rutile as a feedstock for 50,000 tons of pigment production per year.

CONSUMPTION AND USES

Concentrates.—Consumption of ilmenite, rutile, and titanium slag decreased 12%, 21%, and 42%, respectively, from 1974 levels.

Metal.—Consumption of sponge and ingot decreased 34% and 22%, respectively. Apparent net shipments of mill products declined 10%. The downturn stemmed primarily from a slump in commercial aircraft production, which at yearend gave no sign of ending. Demand for titanium for use in military aircraft was steady, but increased usage in this application, while reasonably certain, is indefinite as to time. Some gains in industrial demand were evident, and gains in titanium castings for both industrial and aerospace uses were substantial.

The strongest demand for titanium from the industrial sector emerged from power installations and from the chemical process industries. It was reported about midyear that 25 powerplants had titanium condenser tubing installed, on order, or specified. Titanium was being used for the internal fittings of cooling towers. Use of titanium cathodes in copper refining, first tried in 1960, has been steadily increasing as the technology becomes better understood.

Table 5.—Consumption of titanium concentrates in the United States, by product

(Short tons)

Year and product	Ilmenite [1]		Titanium slag		Rutile	
	Gross weight	TiO_2 content [e]	Gross weight	TiO_2 content [e]	Gross weight	TiO_2 content [e]
1971	898,783	486,271	143,554	101,751	225,498	215,916
1972	786,384	461,422	264,095	187,608	242,758	232,231
1973	807,733	479,231	281,791	199,287	276,907	263,365
1974:						
Alloys and carbide	(2)	(2)	(3)	(3)	(2)	(3)
Pigments	839,284	492,206	257,125	182,257	241,003	228,507
Welding-rod coatings and fluxes	(2)	(2)	--	--	11,759	11,181
Miscellaneous [4]	12,693	9,070	--	--	39,899	38,032
Total	851,977	501,276	257,125	182,257	292,661	277,720

See footnotes at end of table.

Table 5.—Consumption of titanium concentrates in the United States, by product—Continued

(Short tons)

Year and product	Ilmenite [1] Gross weight	Ilmenite [1] TiO_2 content [e]	Titanium slag Gross weight	Titanium slag TiO_2 content [e]	Rutile Gross weight	Rutile TiO_2 content [e]
1975:						
Alloys and carbide	(2)	(2)	(3)	(3)	(2)	(2)
Pigments	737,209	424,302	147,965	104,585	191,750	181,128
Welding-rod coatings and fluxes	(2)	(2)	--	--	10,316	9,779
Miscellaneous [4]	10,612	8,107	--	--	29,361	28,013
Total	747,821	432,409	147,965	104,585	231,427	218,920

[e] Estimate.
[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite.
[2] Included with "Miscellaneous" to avoid disclosing individual company confidential data.
[3] Included with "Pigments" to avoid disclosing individual company confidential data.
[4] Includes ceramics, chemicals, glass fibers, and titanium metal.

Table 6.—Distribution of titanium-pigment shipments, by industry

(Percent)

Industry	1971	1972	1973	1974	1975
Distribution by gross weight:					
Paints, varnishes, lacquers	57.7	53.0	52.7	52.6	58.8
Paper	17.8	20.4	19.6	18.5	18.8
Plastics (except floor covering and vinyl-coated fabrics and textiles)	6.5	7.7	9.8	11.3	7.4
Rubber	2.7	3.6	3.2	2.7	2.8
Ceramics	2.0	2.3	2.5	2.1	1.9
Other	10.0	11.8	9.9	8.9	7.7
Exports	3.3	1.2	2.3	3.9	2.6
Total	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:					
Paints, varnishes, lacquers	54.4	52.0	52.5	52.5	58.7
Paper	19.7	20.9	19.8	18.7	19.0
Plastics (except floor covering and vinyl-coated fabrics and textiles)	7.1	7.9	9.8	11.3	7.4
Rubber	3.0	3.7	3.2	2.7	2.8
Ceramics	2.2	2.4	2.6	2.1	1.9
Other	10.3	11.9	9.8	8.8	7.6
Exports	3.3	1.2	2.3	3.9	2.6
Total	100.0	100.0	100.0	100.0	100.0

In the aircraft field, British Aircraft Corp. was reportedly replacing steel with titanium castings on engine mounts in Jaguar planes. Pratt & Whitney Division of Colt Industries, Inc. reported 900 pounds of titanium in each of its F100 turbofan engines.

Carbides.—A domestic manufacturer of carbide cutting tools predicted major gains by cemented titanium carbide in steel-cutting tools by 1985. Several larger companies whose operations include extensive metalworking announced full-scale or experimental use of titanium carbide in place of tungsten carbide. In Japan, Toyo Soda Manufacturing Co. Ltd. began test production of titanium carbides by a newly developed process. Feedstock is understood to be titanium trichloride.

Pigment.—Preliminary figures showed a 24% decrease in shipments. Domestic production of thermoplastic resins was down sharply during the year, and demand for pigment by this industry was about 41,000 tons, less than half of the 1974 requirements. Paint manufacturers used 59,000 fewer tons than in 1974. However, inventories in general were far enough depleted by March or April to bring about increased production. New orders continued to increase through August in anticipation of a rise in price.

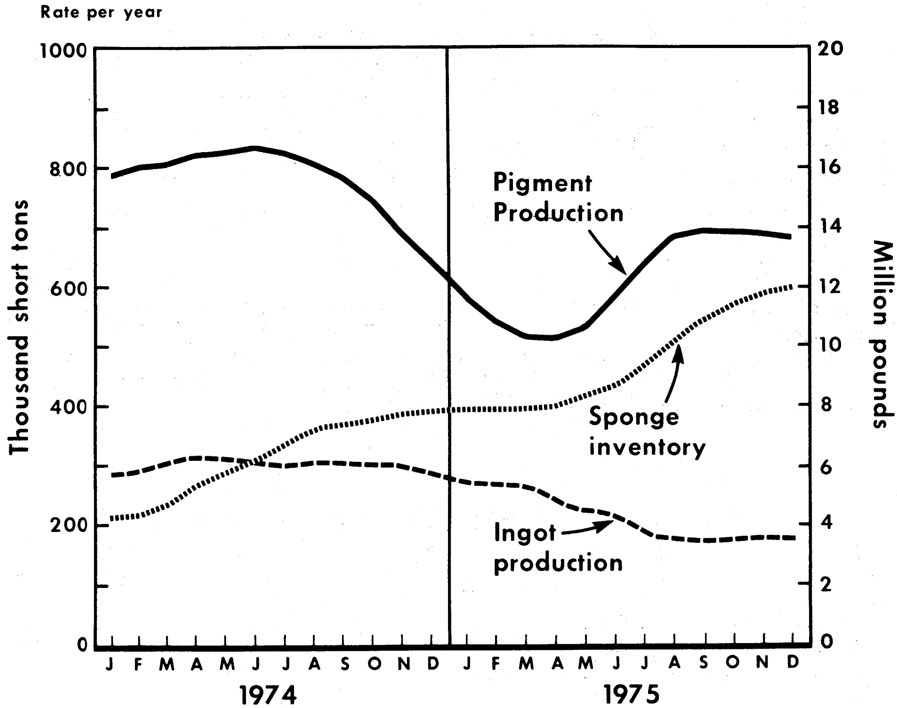

Figure 1.—Salient trends of titanium products, 1974–75.

STOCKS

In 1975, consumers began to replenish inventories of ilmenite, rutile, and slag depleted during the high-demand years of 1972–74. Increases were 13%, 29%, and 51%, respectively. Stocks of titanium sponge increased throughout 1975, and at yearend had leveled out at 48% higher than the December 1974 figure. Scrap inventories were 11% higher. Industry stocks of various grades of titanium pigment were 86,357 tons at yearend 1975, little changed from yearend 1974.

Table 7.—Stocks of titanium concentrates in the United States, December 31
(Short tons)

	Gross weight	TiO_2 content [e]
Ilmenite:		
1973	567,826	329,477
1974 [r]	572,597	325,918
1975 [p]	649,537	386,307
Titanium slag:		
1973	111,014	78,650
1974 [r]	57,932	40,836
1975 [p]	87,683	62,130
Rutile:		
1973	147,691	139,641
1974 [r]	107,821	101,394
1975 [p]	139,571	131,740

[e] Estimate. [p] Preliminary. [r] Revised.

PRICES

Concentrates.—Price quotations for ilmenite in domestic markets remained at $55 per long ton throughout the year. Australian ilmenite prices increased to the A$15 to A$18 per long ton range at the first of the year and remained at that level, f.o.b. mines. Indian concentrates (58% to 60% TiO_2) moved from US$16.50 to US$23 per long ton, f.o.b. Indian ports, about midyear. Malayan ilmenite sold in the same price range as Australian material.

Rutile, bulk, f.o.b. cars at Atlantic, Gulf, and Great Lake ports, was quoted at $710 per short ton throughout the year. This was a spot price; long-term contracts presumably were concluded at somewhat lower figures. Declared valuations of shipments entering U.S. ports were as high as $525 per short ton in a few cases, but most valuations were less than $450. Weakness appeared early in the year in Australia, when spot prices dropped to A$375 to A$395 per metric ton. One source quoted rutile at A$290 to A$330 in January, A$270 to A$300 in September, and A$250 to A$280 in December.

Titanium slag, f.o.b. Sorel, Quebec, rose to $75 per long ton on January 1, and remained at that price until the yearend. Synthetic rutile is not yet a sufficiently standard item of commerce to warrant price quotations, but shipments from Australia, Japan, India, and Taiwan averaged about $200 per short ton, c.i.f.

Metal.—Domestic sponge began the year at $2.45 per pound, but was raised to $2.70 on August 1, ending the year at that level. GSA offered about 1 million pounds of sponge for sale, but bids opened June 25 contained no acceptable offers. Japanese sponge began the year at $2.85 per pound, but decreased to the $2.65 to $2.70 range at midyear, where it remained through the yearend. Titanium mill product prices were increased substantially in January; a further small increase took place in June.

Pigment.—An attempt to raise prices early in the year was not supported, but rising costs of energy and chlorine, and additional costs from pollution control activities, put upward pressure on prices in the face of a declining market. The market, however, reached its low point in early spring, and a price increase of 3½ cents per pound was announced, effective early in August, for all grades of pigment. Yearend prices, with minor variations, were 38½ cents per pound for anatase pigment and 43½ cents per pound for rutile pigment.

FOREIGN TRADE

Titanium dioxide exports in 1975 amounted to 15,807 tons, about half of the 1974 total. Of the year's total, Canada took 14.2%, Venezuela 14.0%, Brazil 6.3%, other Latin America and West Indies nations 22.6%, West Germany 5.1%, Western Europe 7.0%, Japan and the Republic of Korea 9.0% each, and other Far Eastern countries 9.7%.

Exports of unwrought, waste, and scrap titanium were 8.5% less than in 1974; 32% went to Belgium, 28% to the United Kingdom, and 16% to Italy. The average valuation was 88 cents per pound, 10 cents less than in 1974. Exports of wrought titanium were 11% greater than in the previous year.

Imports of ilmenite from Australia in 1975 were 52% greater than in 1974. Imports of Sorel slag were 10% less than in 1974. Imports of natural rutile declined 14%, but imports of synthetic rutile were 12% greater than 1974 levels.

Imports of unwrought, waste, and scrap titanium were about half those of 1974. Of the total, 4,190 tons was sponge, which came from Japan (2,404 tons), the U.S.S.R. (1,313 tons), and the United Kingdom (473 tons). The sponge shipments bore an average declared valuation of $1.89, $1.47, and $1.29 per pound, respectively.

Imports of pigment came to 25,918 tons during the year, and constituted 4% of domestic consumption.

Table 8.—U.S. exports of titanium products, by class

Year	Ores and concentrates		Metal and alloy sponge and scrap		Intermediate mill shapes and mill products, n.e.c.		Pigments and oxides	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	1,494	$353	4,142	$3,601	745	$8,748	20,769	$14,021
1974	3,264	727	4,730	9,288	1,719	19,600	[1]30,379	[1]24,575
1975	3,147	505	4,326	7,630	1,900	24,726	15,807	12,110

[1] Data adjusted by the Bureau of Mines, U.S. Department of the Interior.

Table 9.—U.S. imports for consumption of titanium concentrates, by country [1]

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Ilmenite:						
Australia	r 29,540	$378	64,506	$1,176	98,352	$1,674
Canada	172	6	305	12	221	11
India	3,360	30	[2]17,637	260	19,428	317
Malaysia	16,327	224	--	--	--	--
Sri Lanka	--	--	--	--	4,010	57
Sweden [3]	20,242	236	--	--	--	--
Total	r 69,641	[4]875	82,448	1,448	[4]122,010	2,059
Titanium slag [5]	237,248	10,981	236,272	12,267	212,682	13,844
Rutile, natural:						
Australia	r 172,028	r 24,068	r 189,622	r 31,758	166,298	35,494
Canada [3]	134	18	586	277	135	58
Denmark [3]	20	3	--	--	--	--
India	--	--	4,409	827	--	--
Malaysia [3]	23	5	--	--	--	--
Total	r 172,205	r 24,094	r 194,617	r 32,862	166,433	35,552
Rutile, synthetic:						
Australia [1]	2,274	208	14,454	1,851	34,222	6,218
India	33,516	2,523	10,976	1,348	6,614	900
Japan	18,865	1,696	26,442	2,712	16,878	3,599
Taiwan	--	--	--	--	353	92
Total	54,655	4,427	51,872	5,911	[4]58,066	[4]10,810
Titaniferous iron ore: [6]						
Canada	83,513	1,395	201,256	2,373	46,031	1,255
New Zealand	--	--	--	--	21	1
Total	83,513	1,395	201,256	2,373	46,052	1,256

r Revised.
[1] Data adjusted by the Bureau of Mines, U.S. Department of the Interior.
[2] May have been used in heavy aggregate.
[3] Country of transshipment rather than country of production.
[4] Data do not add to total shown because of independent rounding.
[5] All from Canada.
[6] Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel furnace flux.

Table 10.—U.S. imports for consumption of unwrought titanium and waste and scrap

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Australia	--	--	--	--	3	$5
Austria	758	$404	1,299	$874	--	--
Belgium-Luxembourg	--	--	14	8	--	--
Canada	120	116	142	194	154	230
France	17	20	79	149	41	92
Germany, West	311	492	247	556	69	185
Italy	11	9	--	--	--	--
Japan	2,960	5,508	2,797	6,510	2,545	9,882
Mexico	--	--	5	3	3	3
Netherlands	12	17	--	--	18	31
Sweden	--	--	244	211	4	11
U.S.S.R	1,628	2,504	4,032	7,410	1,698	4,326
United Kingdom	824	1,401	979	1,972	531	1,346
Total	6,641	10,471	9,838	17,887	5,066	16,111

WORLD REVIEW

Australia.—A meeting of representatives of the Department of Minerals and Energy and of the Australian mineral sands industry took place on June 6. The following press statement was issued:

"They (the producers) have resolved that in the best interests of consumers and the balanced development of the Australian mineral sands industry, they will arrange the supply of mineral sand products in a manner that will allow a stable long term supply of these commodities at reasonable prices commensurate with their value.

"To that end, the Department of Minerals and Energy and the industry have undertaken to examine urgently all current and future aspects of the industry in order to determine demand and pricing patterns and to state a policy including pricing of mineral sand products."

This was interpreted in some quarters as approaching the formation of a cartel, which was vigorously denied by the 14 major Australian producers.

The Western Australian Minister for Mines in February stated that the new estimate of reserves in the State totaled 80.4 million metric tons of heavy sands. Geographically, 37.1 million tons are in the Eneabba district, 32.5 million tons are in the Capel district, and 10.7 million tons at scattered locations. The total includes 51.7 million tons of ilmenite, 3.9 million tons of rutile, 10.8 million tons of zircon, and 14.0 million tons of other minerals.

Table 11.—Titanium: World production of concentrates (ilmenite, rutile, and titaniferous slag) by country
(Short tons)

Country [1]	1973	1974	1975 [p]
Ilmenite: [2]			
Australia [3]	[r] 793,223	900,307	1,116,735
Brazil	[r] 11,355	7,433	[e] 6,300
Finland	175,267	167,551	135,143
India	85,088	[e] 85,000	[e] 83,000
Malaysia [4]	[r] 204,384	169,238	[e] 127,000
Norway	[r] 829,967	934,911	580,812
Portugal	672	302	[e] 165
Spain	4,108	--	--
Sri Lanka	103,046	89,395	[e] 88,000
United States [5]	776,013	744,571	717,281
Total	[r] 2,983,123	3,098,708	2,854,436
Rutile:			
Australia	[r] 369,528	351,308	379,332
Brazil	[r] 196	161	[e] 150
India	3,748	[e] 3,800	[e] 3,800
Sri Lanka	2,482	3,363	[e] 3,300
United States	[r] 9,330	6,446	W
Total	[r] 385,284	365,078	[6] 386,582
Titaniferous slag:			
Canada [7]	942,704	931,168	826,560
Japan	4,690	4,855	4,942
Total	947,394	936,023	831,502

[e] Estimate. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] In addition to the countries listed, the U.S.S.R. and the Republic of Korea also produce titanium concentrates, but available information is inadequate to make reliable estimates of output levels.
[2] Titaniferous slag production in Canada and Japan is reported separately. Ilmenite produced in Canada goes almost entirely into slag production; separate figures are not available.
[3] Includes leucoxene.
[4] Exports.
[5] Includes a mixed product containing ilmenite, leucoxene, and rutile.
[6] Does not contain United States production in order to avoid disclosing individual company data.
[7] Contains 70% to 72% TiO_2.

In the Capel district, producers include Western Titanium, Ltd., Westralian Sands, Ltd., Cable Sands Pty., Western Mineral Sands, Pty., Ltd., and Mid-East Minerals, N.L. In the Eneabba district, A. V. Jennings Mining Co. and Allied Eneabba Pty., Ltd. came into full production during the last half of 1975; Western Titanium was building a plant to begin operation in 1976, and a fourth company, Ilmenite Pty., Ltd., while holding mineral lands, was inactive. At Jurien Bay, WMC Minerals Sands engaged in shakedown operation of its new plant. The joint venture of Westralian Sands and Lennard Oil, Ltd. at Gingin was inactive pending market improvement.

Western Titanium, at its new plant in the Eneabba area, expects to be in full production early in 1977, and to produce 150,000 tons of ilmenite, 30,000 tons of rutile, and 70,000 tons of zircon per year. The company is 85% owned by Consolidated Gold Fields Ltd. of Australia.

In 1974, Westralian Sands introduced a new product, HYTI 68, an ilmenite-leucoxene concentrate containing 68% TiO_2.

After some early difficulties, A. V. Jennings Mining Ltd. reached capacity production about midyear. Annual production of 40,000 tons of rutile, 160,000 tons of ilmenite, and 30,000 tons of zircon is scheduled.

Allied Eneabba Pty., Ltd., owned 25% of E. I. du Pont de Nemours & Co., Inc., began operations in August. Reserves are estimated at 8.54 million tons proven sands and 30.57 million tons of probable sands. Fluor Australia Pty., Ltd., contracted for plant construction and housing.

Late in 1974, Western Mining Corp., Ltd., exercised its option on the Jurien Bay heavy mineral deposit owned by Black Sands, Ltd., and began building a mining and concentrating plant. The company, jointly with Mitsubishi Chemical Industries, Ltd., was also considering construction of a synthetic rutile plant at the mine site.

Western Titanium produced 34,931 metric tons of synthetic rutile at its new 38,500-ton plant in its 1974 fiscal year ending June 30. The company closed its older 14,000-ton plant because of weakening demand, rising costs, and delayed official approval for exports. The plant had produced 11,400 tons of synthetic rutile in its 1974 fiscal year.

Rutile & Zircon Mines (Newcastle) Ltd. announced a joint feasibility study with Akzo Zout Chemie, of the Netherlands, for upgrading ilmenite by a new high-temperature chlorination process. A pilot plant at Mt. Morgan, Queensland, will be used.

DM Minerals, a joint venture of Murphyores Holdings, Ltd., and Dillingham Mining Corp. of Australia, Ltd., began operation of its mining plant on Fraser Island about midyear. Environmental groups, to some extent supported by the Australian Government, continued to oppose the mining operation.

Australian pigment producers were proceeding with major expansion plans. Laporte Australia, Ltd., announced its intention to expand capacity of its plant at Bunbury from 24,000 tons to 40,000 tons per year. Tioxide Australia Pty., Ltd., owned by British Titan Products, Ltd., will expand its plant capacity at Burnie from 29,000 tons to 35,000 tons per year.

Brazil.—Early in the year, Cia. Vale do Rio Doce announced plans for a major phosphate fertilizer plant at Tapira, Minas Gerais, a major byproduct of which will be anatase. Reserves were said to contain 45 million tons of TiO_2. Association in the titanium venture with the Japanese Ishihara group was a possibility. A pigment plant, if constructed, will be operative in 1978 or early 1979.

Canada.—Construction of the 22,000 ton synthetic rutile pilot plant of the Canadian Tiron Chemical Corp. at Pointe-aux-Trembles, Quebec, was said to be nearing completion in February. Plant capacity was given at 22,000 tons per year. Ore will be obtained from the St. Urbain district. Gulf Titanium, Ltd., was reportedly raising funds to construct a similar but smaller plant.

Quebec Iron and Titanium Corp. reported production of 738,000 tons of Sorel slag from 1,796,200 tons of titaniferous iron ore. Production was less than normal because of a breakdown of one of the smelting furnaces. A 2-week strike at Sorel also contributed to the decrease.

European Economic Community (EEC).—The EEC Commission has drafted a regulation, subject to approval of the Council of Ministers, requiring a 95%

reduction of sulfate-process pigment plant effluents within 10 years after the regulation becomes official. The timetable requires member states to apply abatement methods within 18 months. The Commission did not prescribe the abatement techniques to be used. Based on total European production of pigment, 87% of effluent is now discharged into the North Sea and the English Channel.

Ireland.—The Du Pont company relinquished its option on industrial land on tidewater at Ringaskiddy, County Cork. Plans for construction of a plant to make 100,000 tons per year of a titanium intermediate have been postponed indefinitely.

Italy.—After efforts to handle waste from its sulfate-process pigment plant at Scarlino proved ineffective, Montecatini-Edison, S.p.A. suspended operations. High plant and operating costs forecast for a treatment plant, for which technology was provided by New Jersey Zinc Co., caused abandonment of this project.

Netherlands.—B.V. Titaandioxydefabrick Tiofine, a pigment producer partly owned by American Cyanamid Co., closed its plant near Rotterdam for 6 weeks early in the year for inventory adjustment, following similar action by other producers in Western Europe.

United Kingdom.—Laporte Industries (Holdings) Ltd., operating its Stallingborough pigment plant at half capacity, laid off employees at the first of the year. The company's report for the first half-year confirmed a 50% sales volume, and expected no improvement through the yearend. British Titan, Ltd., similarly operated at half capacity throughout the year at its plant at Teesside.

India.—Reports in August dealt with construction, by Indian Rare Earths, Ltd., of a sand treatment plant at Gopalpur in southern Orissa. Monazite production was the primary purpose of the plant, but it is scheduled also to produce 240,000 tons of ilmenite and 10,000 tons of rutile annually.

Japan.—Toho Titanium Co., Ltd., and Osaka Titanium Co. produced 8,358 short tons of sponge in 1975, a decrease of 15% from 1974 production. Exports of sponge and of fabricated products through July were 1,864 tons and 587 tons, respectively; the United States received 78% of the sponge, while the Netherlands and other Western European nations received 20%. Domestic consumption of sponge, almost all for industrial uses, continued slowly to increase.

In March, negotiations between Mitsubishi Metal Corp. and an as yet unidentified United States company with ilmenite holdings were reported. A 5,000 to 6,000 ton per year production of synthetic rutile in the United States was being considered.

Malaysia.—Sakai Trading Co., jointly with Klöckner-Werke AG and Malaysian interests, were reported forming a company to develop a 2- to 3-million-ton ilmenite deposit in northeast Malaysia. Production of 10,000 tons is targeted for 1976, and 50,000 tons per year thereafter.

Straits Trading Co., Ltd., announced it would take 30% of the shares of Malaysian Titanium Corp., which intends building a 55,000-ton-per-year synthetic rutile plant in Ipoh. Tailings from Straits' tin smelter will be the principal source of ilmenite.

Sakai Chemical Industry Co. and Toyo Soda Manufacturing Co. jointly formed Shin-Nanyo Titanium Co. to produce titanium pigment. Technology of the Kerr-McGee Chemical Co. will be used.

Sierra Leone.—Representatives of the Sierra Leone Government, Bethlehem Steel Corp. and Nord Resources Co. reached final agreement on May 22 on plans to mine rutile at Gbangbama. The agreement was ratified by the Sierra Leone Parliament on July 3. A company named Sierra Rutile, Ltd., of which Bethlehem had an 80% interest, was formed to conduct operations, which are to come onstream late in 1977. Sierra Rutile hopes for an eventual annual rate of 100,000 to 125,000 tons of rutile from a deposit which contains 3 million tons.

The predecessor corporation at this deposit was Sherbro Minerals Co., Ltd., jointly owned by British Titan Products, Ltd., and Pittsburgh Plate Glass Co. Its leases were relinquished upon declaring bankruptcy in 1971. Leases at Bonthe and Moyamba were acquired by a joint subsidiary of Bayer A.G. and Preussag Metall. The subsidiary, Bayer-Preussag Mining Co., resumed mining on these leases in 1973, and was expected to construct a pilot plant in 1976.

South Africa, Republic of.—Concessions for prospecting coastal heavy sand deposits between Richards Bay and the Mozambique border reportedly have been issued to

United States Steel International Inc. and New Jersey Zinc Exploration Co. Objections on environmental grounds are in full course, but do not include the Richards Bay operation of Quebec Iron and Titanium Corp., Ltd., the South African government, and Union Corp. Ltd., which has been pronounced free of environmental hazard. These companies continued their planned development through the year.

Spain.—Titanio, S.A., received official approval to build a sulfuric acid plant of 330,000-tons-per-year capacity next to its pigment plant, which is now under construction.

Taiwan.—The first production unit of the synthetic rutile plant of Taiwan Alkali Co. at Kaohsiung was completed in July, although some shipments were made earlier. A second 15,000-ton unit is under construction.

TECHNOLOGY

The U.S. Geological Survey, the geological surveys of Georgia, North Carolina, and South Carolina, and the Coastal Plans Regional Commission conducted aerial radioactivity surveys over the three States. The results suggested anomalous concentrations of heavy sands in several places, notably in southeastern Georgia.

Energy requirements for producing titanium metal and pigment with various feed materials and by various processes were included in a report to the Bureau of Mines by Battelle Columbus Laboratories.[3]

Significant papers were published on production of synthetic rutile[4], direct chlorination of ilmenite[5], fused-salt electrodeposition of titanium[6], and recovery of chlorine and iron oxide from ferric chloride[7]; the latter is important to effluent control. Titanium dioxide was suggested for use in emission control of automobile exhausts.[8]

Du Pont introduced a scaled-down titanium dioxide slurry dispenser for the use of intermediate-scale consumers. Containing 5,000 gallons, it may be refilled from tank trucks.

Grumann Aerospace Corp. introduced a combination of forming and welding techniques to produce work requiring less machining and consequently producing less scrap. Diffusion bonding was being used by Rockwell International Corp., and a process called isothermal forging was developed by the Air Force Materials Laboratory, with substantially the same purpose in mind.

The first International Titanium Casting seminar took place in London, England, in 1974; discussions included applicability, engineering design, and quality control.

Comprehensive engineering specifications and properties of titanium alloys were published in manual form for the use of design engineers.[9]

A problem in processing and recycling titanium scrap became evident during the year when defective ingots were found to have a high content of yttrium, and yttrium oxide inclusions appeared in otherwise sound ingots. Acceptance standards were amended to include a maximum yttrium content of 30 ppm.

Bureau of Mines researchers published reports related to titanium during the year.[10]

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[3] Battelle Columbus Laboratories. Interim Report on Energy Use Patterns in Metallurgical and Nonmetallic Mineral Processing. Sept. 16, 1975, pp. 172–202.

[4] Mackey, T. S. Selective Leaching of Iron From Ilmenite to Produce Synthetic Rutile. Australian Min., v. 66, No. 9, September 1974, p. 44ff.

[5] Dooley, G. J., III. Titanium Production: Ilmenite vs. Rutile. J. Metals, v. 27, No. 3, March 1975, pp. 8–16.

[6] Tukumoto, S., E. Tanaka, and K. Ogisu. The Deposition of Titanium Metal by Fusion Electrolysis. J. Metals, v. 27, No. 11, November 1975, pp. 18–23.

[7] Paige, J. I., G. B. Robidart, H. M. Harris, and T. T. Campbell. Recovery of Chlorine and Iron Oxide From Ferric Chloride. J. Metals, v. 27, No. 11, November 1975, pp. 12–16.

[8] Tien, T. Y., H. L. Stadler, E. F. Gibbons, and P. J. Zacmandis. TiO_2 as an Air-to-Fuel Ratio Sensor for Automobile Exhausts. Bull. Am. Ceram. Soc., v. 54, No. 3, March 1975, pp. 280–282.

[9] Materials Engineering. Titanium and Its Alloys. V. 80, No. 1, July 1974, pp. 61–70.

[10] Gomes, J. M., K. Uchida, and M. M. Wong. Electrolytic Preparation of Titanium and Zirconium Diborides From Their Oxides and Mineral Concentrates. BuMines RI 8053, 1975, 14 pp.

MacDonald, D. J., A. E. Raddatz, T. A. Henrie, and E. K. Kleespies. Electrochemical Kinetics of the Reaction of Titanium Metal With Titanium Subchlorides in Molten Sodium Chloride. BuMines RI 7919, 1975, 16 pp.

Tungsten

By Richard F. Stevens, Jr.[1]

Domestic production and consumption of tungsten concentrate fell 24% and 14% to 5.6 and 14.0 million pounds, respectively, compared with that of 1974. Over 95% of the domestic concentrate production was obtained from two essentially continuous operations, one in California and one in Colorado. Production and consumption of ammonium paratungstate decreased 30% and 34%, respectively, while production and consumption of tungsten products in 1975 each fell 37%. Imports for consumption of tungsten concentrate decreased 41% to 6.6 million pounds while exports of tungsten concentrate, from sales of Government stockpile excesses, rose 11% to 1.3 million pounds of contained tungsten in 1975. Estimated world production of tungsten concentrate rose 1% to 82.6 million pounds during the year.

The reported price of tungsten concentrate shipments, f.o.b. domestic mines and custom mills, increased 11% and averaged $84 per short ton unit.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient tungsten statistics

(Thousand pounds of contained tungsten and thousand dollars)

	1971	1972	1973	1974	1975
United States:					
Concentrate:					
Mine production	6,900	8,150	7,575	7,381	5,588
Mine shipments	6,827	7,045	7,059	7,836	5,490
Value	20,184	18,104	19,154	37,413	29,090
Consumption	11,622	14,107	15,386	16,298	14,012
Releases from Government stocks	1,381	3	1,498	6,071	4,135
Exports [1]	2,006	95	90	1,187	1,316
Imports, general	577	5,898	11,047	11,786	6,908
Imports for consumption	418	5,739	10,834	11,096	6,570
Stocks, Dec. 31:					
Producers	863	1,966	225	529	531
Consumers	2,657	2,229	1,446	1,565	1,958
Employment [2]	470	510	535	540	525
Ammonium paratungstate:					
Production	(3)	(3)	13,012	14,707	10,282
Consumption	(3)	(3)	13,945	15,733	10,353
Stocks, Dec. 31: Producers and consumers	(3)	(3)	945	1,062	1,704
Primary products:					
Production	11,730	14,090	16,600	20,131	12,634
Consumption	11,159	13,296	17,984	20,556	12,934
Stocks, Dec. 31:					
Producers	3,722	4,680	3,523	3,628	3,976
Consumers	2,541	2,121	2,051	2,771	2,753
World: Concentrate:					
Production	78,055	84,952	r 83,612	r 81,509	82,580
Consumption	68,413	76,583	r 84,857	r 82,015	72,695

r Revised.
[1] Estimated tungsten content.
[2] Estimated number of persons at mines and mills, excluding office workers, at yearend.
[3] Included with primary products.

Legislation and Government Programs.—During the year, the General Services Administration (GSA) continued to sell excess stockpiled tungsten concentrate on the basis of monthly sealed bids. GSA offered material at a disposal rate of 500,000 pounds of contained tungsten per month and sold nearly 2.8 million pounds of concentrate during 1975; 1,337,064 pounds for domestic use, and 1,437,663 pounds for export. The material released for domestic use was sold at prices, ex-duty, ranging from $74.78 to $88.66 per short ton unit. Material for export was sold at prices, also ex-duty, from $76.05 to $89.75 per short ton unit. In addition, 478,713 pounds of tungsten concentrate were awarded in February at an average price of $87.79 per short ton unit, and 376,251 pounds of concentrate were released in May at a price of $86.52 per short to unit, both for use in defense contracts. In December, 504,865 pounds of concentrate was sold to the Government of Israel. This material was to be withdrawn over a 10-month period.

A Congressional bill (H.R. 2826), to temporarily suspend the import duty on tungsten concentrate and on other material in chief value of tungsten, was introduced February 5, 1975, and hearings were held by the Subcommittee on Trade of the House Ways and Means Committee. By yearend, no action had been taken, and the bill was pending before the subcommittee.

Table 2.—U.S. Government tungsten stockpile materials, inventories, and objectives
(Thousand pounds, tungsten content)

Material	Objective	Inventory by Program, Dec. 31, 1975: National (strategic) stockpile	DPA inventory	Supplemental stockpile	Total
Tungsten concentrate:					
Stockpile grade	4,234	67,985	4,240	3,304	75,529
Nonstockpile grade	--	35,536	535	1,153	37,224
Total concentrate inventory	4,234	103,521	4,775	4,457	112,753
Ferrotungsten	--	2,025	--	--	2,025
Tungsten metal powder, hydrogen reduced	--	1,048	--	--	1,048
Tungsten metal powder, carbon reduced	--	717	--	--	717
Tungsten carbide powder	--	953	--	1,080	2,033

Source: Federal Preparedness Agency. Statistical Supplement Stockpile Report to the Congress. LAW-26-AP, July-December 1975, pp. 35-37.

Early in 1975, the U.S. International Trade Commission held hearings throughout the United States to provide data for a staff study on the economic effects of tungsten tariff reductions. A report was sent to the Office of the Special Representative for Trade Negotiations and to the President. The report was transmitted to U.S. tariff negotiators in Geneva, Switzerland, attending meetings of the GATT (General Agreement on Tariffs and Trade).

DOMESTIC PRODUCTION

Domestic tungsten mine production fell 24% compared with that of 1974 and totaled 5.6 million pounds of contained tungsten during the year. Mine shipments decreased 30% to 5.5 million pounds. Although 44 mines in 8 Western States and North Carolina reported production and 43 mines reported concentrate shipments, only 2 mines were operated essentially continuously throughout 1975: The Pine Creek mine and mill of the Metals Div., Union Carbide Corp., (UCC), located northwest of Bishop, Calif., in Inyo County; and the Climax mine and mill of Climax Molybdenum Co., a division of Amax, Inc., at Climax, Colo., in Lake County. The major mineral value recovered at Pine Creek continued to be tungsten with minor amounts of byproduct molybdenum, copper, gold, and silver. UCC processed ore to produce ammonium paratungstate (APT), an intermediate form of tungsten suitable for ready conversion to tungsten metal powder. During August, the Pine Creek facilities were temporarily shut down to allow for maintenance operations.

The major mineral value recovered at Climax was molybdenum. Concentrates of tungsten, tin, and pyrite recovered as coproducts were largely dependent upon the rate of molybdenum production. The maximum tungsten concentrate production capacity at Climax is about 2.5 million pounds of tungsten annually.

Intermittent tungsten concentrate production and/or shipments were also reported from Pima County, Ariz.; Fresno, Inyo, Kern, Los Angeles, Madera, San Bernardino, San Diego, and Tulare Counties, Calif.; Valley County, Idaho; Beaverhead, Deer Lodge and Lincoln Counties, Mont.; Churchill, Elko, Mineral, Nye, Pershing, and White Pine Counties, Nev.; Vance County, N.C.; Box Elder, and Tooele Counties, Utah; and Stevens County, Wash.

The Tungsten Queen mine and mill of Ranchers Exploration & Development Corp., near Townsville in Vance County, N.C., remained closed and on "standby" status throughout the year.

UCC continued development of the Tempiute mine and mill in southern Nevada. The underground mine and adjoining surface mill was rescheduled for completion and startup in mid-1977. When operating at designed capacity, the facility will produce about 2 million pounds of tungsten per year, as well as byproduct zinc concentrate. The scheelite ore at Tempiute will be processed to tungsten semiconcentrate prior to being processed at UCC's Pine Creek (Calif.) facilities to APT.

On June 25, 1975, the tungsten milling equipment previously used by Minerals Engineering Co. at its Glen, Mont., tungsten operation was sold at auction and the plant was liquidated.

The major domestic companies engaged in tungsten operations during 1975 are listed in table 4.

Table 3.—Tungsten concentrate shipped from mines in the United States

Year	Quantity			Reported value f.o.b. mine [1]		
	Short tons 60% WO_3 basis [2]	Short ton units WO_3 [3]	Tungsten content (thousand pounds)	Total (thousands)	Average per unit 60% WO_3	Average per pound of tungsten
1971	7,173	430,427	6,827	$20,184	$46.89	$2.96
1972	7,401	444,145	7,045	18,104	40.77	2.56
1973	7,418	445,051	7,059	19,154	43.04	2.71
1974	8,233	494,012	7,836	37,413	75.73	4.77
1975	5,769	346,112	5,490	29,090	84.05	5.30

[1] Values apply to finished concentrate and are in some instances f.o.b. custom mill.
[2] A short ton of 60% tungsten trioxide (WO_3) contains 951.72 pounds of tungsten.
[3] A short ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten.

Table 4.—Major producers of tungsten concentrate and principal tungsten processors in 1975

Company	Location of mine, mill, or processing plant
Producers of tungsten concentrate:	
Climax Molybdenum Co., a division of AMAX, Inc	Climax, Colo.
Ranchers Exploration & Development Corp.[1]	Townsville, N.C.
Rawhide Mining Co.[2]	Fallon, Nev.
Timm Tungsten Co	Gold Hill, Utah.
Union Carbide Corp., Metals Div.[3]	Bishop, Calif.
Processors of tungsten:[4]	
Adamas Carbide Corp	Kenilworth, N.J.
Fansteel, Inc	North Chicago, Ill.
General Electric Co	Euclid, Ohio, and Detroit, Mich.
GTE Sylvania, Inc., a subsidiary of General Telephone & Electronics Corp	Towanda, Pa.
Kennametal, Inc	Latrobe, Pa., and Fallon, Nev.
Li Tungsten Corp	Glen Cove, N.Y.
Teledyne Firth Sterling	McKeesport, Pa.
Teledyne Wah Chang Huntsville	Huntsville, Ala.
Union Carbide Corp., Metals Div	Niagara Falls, N.Y.
Westinghouse Electric Corp	Bloomfield, N.J.

[1] Produced from material mined in 1970 and 1971.
[2] Produced part of the year.
[3] At its Pine Creek mine and mill in California, Union Carbide Corp. processes ore "straight through" to ammonium paratungstate.
[4] Major consumers of intermediate tungsten products.

CONSUMPTION AND USES

Total tungsten product consumption fell 37% to 12.9 million pounds of contained tungsten during 1975. Although the quantity of tungsten used in cutting and wear-resistant materials, primarily as tungsten carbide (WC), decreased during the year, the manufacture of these materials continued to be the major tungsten product consumer. During 1975, primary end-use consumption categories were cutting and wear-resistant materials, 65%; hard-facing rods, 8%; mill products, 12%; specialty steels (tool, stainless, and alloy), 9%; superalloys, 3%; and chemicals, 2%.

The major consumption distribution of intermediate tungsten products used to make end-use items was as follows: Tungsten carbide (including cemented, crushed and cast, and crystalline), 47%; tungsten metal powder (including carbon- and hydrogen-reduced), 34%; ferrotungsten, 7%; and scrap, 5%.

Figure 2 is a simplified tungsten flow diagram showing the major processing steps, intermediate tungsten products, and major end-use items involved in the tungsten processing industry.

During the year, several special review articles were published that evaluated the use of tungsten in tungsten carbide cutting tools and in specialized elevated temperature applications.[2]

In September, the new Kysor-Dijet carbide plant was dedicated at Kalamazoo, Mich. This facility, operated by the Kysor Machine Tool Division of Kysor Industrial Corp., will produce under license, carbide grades developed by Dijet Industrial Corp. of Osaka, a leading Japanese carbide manufacturer.

Late in the year, the Carmet Co., a subsidiary of Allegheny Ludlum Industries, Inc., announced the investment of more than $1 million in new equipment to increase WC production at its plants in Madison Heights and Bad Axe, Mich.

Early in December, it was announced that General Electric Co., a major tungsten processor, and Utah International Inc. (UI), a mineral resource company,

[2] American Metal Market. Tool Steel. V. 82, No. 18, Sec. 2, Jan. 27, 1975, pp 1A–18A.
———. Stainless Steel. V. 82, No. 28, Supplement, Feb. 10, 1975, pp. 1A–32A.
———.Minerals Today. V. 82, No. 30, Sec. 2, Feb. 12, 1975, pp. 11–20.
———. Cutting Tool Debate. V. 82, No. 37, Feb. 24, 1975, pp. 21–28.
———. Tungsten. V. 82, No. 74, Apr. 16, 1975, pp. 13–24.
———. Ferroalloys. V. 82, No. 99, May 21, 1975, pp. 13–32.
———. Vacuum Metallurgy. V. 82, No. 142, July 23, 1975, pp. 11–22.
———. Machining Centers. V. 82, No. 173, Sept. 8, 1975 pp. 21–36.
———. Abrasives. V. 82, No. 242, Dec. 15, 1975, pp. 19–26.

were considering a merger involving stock valued at $1.9 billion.

Late in 1975, P. R. Mallory & Co. Inc. announced plans to close its Hopkinsville, Ky., plant and to discontinue production and sales of micro-grain tungsten metal and WC powder. The Hopkinsville plant, operated by the Mallory Powder Products Co., a division of P. R. Mallory, employed 13 workers. Mallory's main operation in Indianapolis, Ind., continued production of the refractory metal powders tungsten, molybdenum, and chromium.

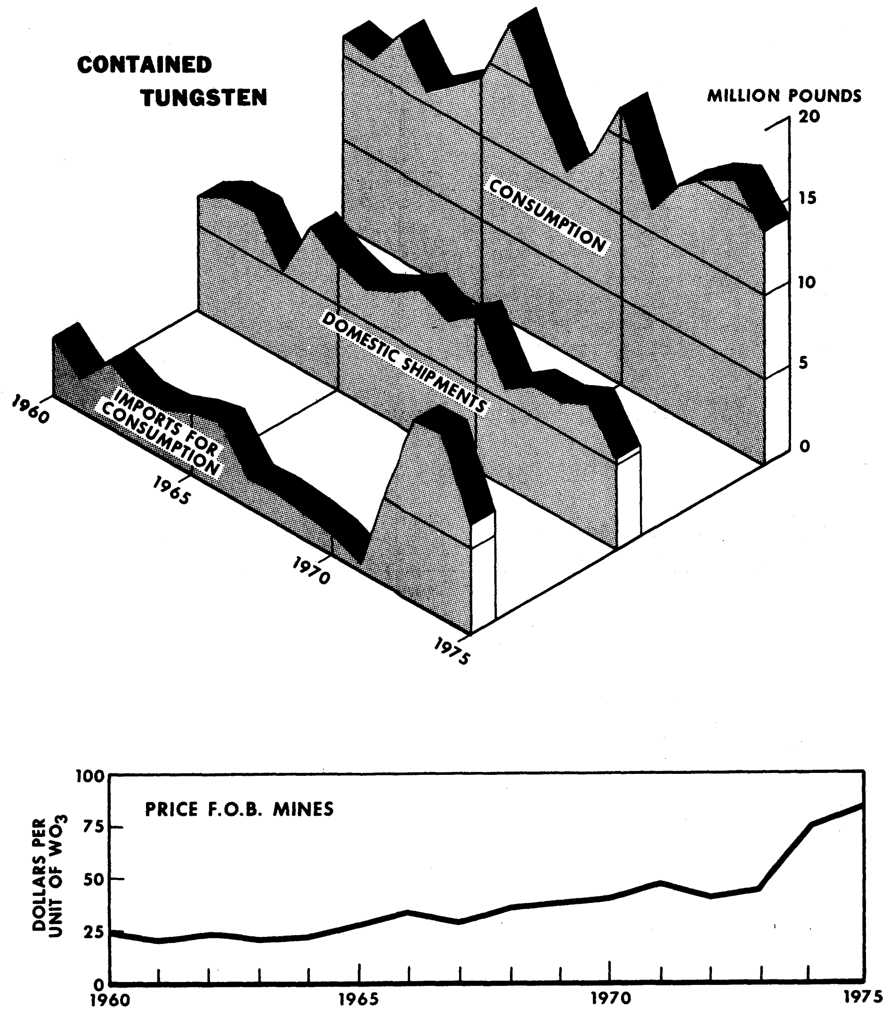

Figure 1.—Domestic shipments, imports, consumption, and average price of tungsten concentrate.

SIMPLIFIED TUNGSTEN FLOW DIAGRAM

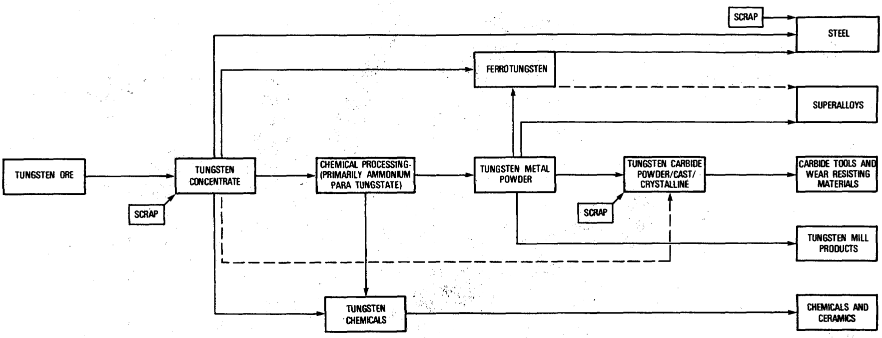

Figure 2.—Simplified tungsten flow diagram.

Table 5.—Production, disposition, and stocks of tungsten products in the United States

(Thousand pounds of contained tungsten)

	Hydrogen and carbon-reduced metal powder	Tungsten carbide powder: Made from metal powder	Tungsten carbide powder: Crushed and crystalline	Chemicals	Other [1]	Total [2]
1974						
Gross production during year	15,234	9,824	3,167	6,002	1,559	35,786
Used to make other products listed here	10,499	--	161	4,995	1	15,655
Net production	4,735	9,824	3,006	1,007	1,558	20,131
Disposition:						
To other processors	1,963	49	W	103	2,360	4,475
To end-use consumers	8,303	7,683	754	772	369	17,883
To make products not listed on this table	2,069	2,359	W	W	2,231	6,659
Producer stocks, Dec. 31	1,908	635	515	338	233	3,628
1975						
Gross production during year	9,782	7,022	1,716	3,697	1,108	23,325
Used to make other products listed here	7,167	--	249	3,275	(3)	10,691
Net production	2,615	7,022	1,467	422	1,108	12,634
Disposition:						
To other processors	1,101	226	329	101	834	2,592
To end-use consumers	4,783	5,589	383	319	197	11,272
To make products not listed on this table	723	1,331	1,168	9	--	3,231
Producer stocks, Dec. 31	1,998	707	598	352	322	3,976

W Withheld to avoid disclosing individual company confidential data; included in "Other."
[1] Includes ferrotungsten, scheelite (produced from scrap), nickel-tungsten, self reducing oxide, pellets, and quantities indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than ½ unit.

STOCKS

Reported stocks of tungsten concentrate held at domestic mines at yearend 1975 increased slightly, and tungsten concentrate held by consumers increased 20% during the year. Stocks of APT rose 60% over those of 1974. Producer's stocks of intermediate tungsten products increased 10% while consumers stocks of intermediate products decreased slightly as indicated in tables 1, 5, and 6.

Table 6.—Consumption and stocks of tungsten products in the United States, by end use
(Thousand pounds of contained tungsten)

End use	Ferro-tungsten [1]	Tungsten metal powder [2]	Tungsten carbide powder	Other tungsten materials [3]	Total
1974					
Steel:					
Stainless and heat resisting	142	--	--	116	258
Alloy	245	W	--	396	641
Tool	1,402	--	--	642	[4] 2,045
Cast irons	1	--	--	--	1
Superalloys	128	138	W	341	607
Alloys (excludes steels and superalloys):					
Cutting and wear-resistant materials	W	3,683	8,216	340	12,239
Other alloys [5]	94	946	480	138	1,658
Mill products made from metal powder	W	2,673	W	--	2,673
Chemical and ceramic uses	--	--	W	159	159
Miscellaneous and unspecified	4	14	256	1	275
Total	2,016	7,454	8,952	[4] 2,134	20,556
Consumer stocks, Dec. 31, 1974	491	622	1,078	580	2,771
1975					
Steel:					
Stainless and heat resisting	86	--	--	72	158
Alloy	69	--	--	70	139
Tool	566	--	--	326	892
Cast irons	4	--	--	--	4
Superalloys	77	69	--	233	379
Alloys (excludes steels and superalloys):					
Cutting and wear-resistant materials	--	2,316	5,709	330	8,355
Other alloys [5]	103	518	268	128	1,017
Mill products made from metal powder	--	1,490	W	--	1,490
Chemical and ceramic uses	--	--	W	310	310
Miscellaneous and unspecified	1	6	153	30	190
Total	906	4,399	6,130	1,499	12,934
Consumer stocks, Dec. 31, 1975	231	713	1,247	562	2,753

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."
[1] Includes melting base self-reducing tungsten.
[2] Includes both carbon-reduced and hydrogen-reduced tungsten metal powder.
[3] Includes tungsten chemicals, natural and synthetic scheelite, tungsten scrap, and other.
[4] Data may not add to totals shown because of independent rounding.
[5] Includes welding and hard-facing rods and materials and nonferrous alloys.

PRICES AND SPECIFICATIONS

The average value of tungsten concentrate shipped from domestic mines and mills, as reported to the Bureau of Mines, increased 11% compared with that of 1974 to \$84.05 per short ton unit of WO_3 in 1975. Excess tungsten concentrate for domestic use was purchased from GSA during the year at prices, ex-duty, ranging from \$74.78 to \$88.66 per short ton unit. The price of tungsten concentrate purchased for export ranged from \$76.05 to \$89.75 per short ton unit. In February and in May, excess stockpiled tungsten concentrate was awarded for Government defense contracts at an average price of \$87.79 and \$86.52 per short ton unit, respectively.

As quoted in the Metal Bulletin (London) and reported in Metals Week, the European price of tungsten concentrate shown in table 7 remained relatively stable throughout the year and ranged from a high of £45.50 per metric ton unit in February (about $94.73 per short ton unit depending upon the prevailing rate of currency exchange) to a low of £36.75 per metric ton unit (about $73.30 per short ton unit) in July.

The price of APT delivered to large-volume contract customers was $116.50 per short ton unit at the beginning of 1975. The price decreased to $110 per short ton unit in April and to $106 per short ton unit in August. The price of "Blue Oxide" remained at $2 per short ton unit above the APT price plus a 1% surcharge to cover processing losses.

In January a conversion fee of $17 per short ton unit was charged for "toll" processing tungsten concentrate to APT at a recovery rate of about 96%. In July the tolling charge was increased to $18.50 per short ton unit.

The price of hydrogen-reduced tungsten metal powder (99.99% purity), f.o.b. shipping point, as quoted in Metals Week, ranged from $10.21 to $12.01 per pound of contained tungsten during 1975. Within this range the price was primarily dependent upon the powder particle size (Fisher number).

UCAR ferrotungsten, a proprietary high-purity ferroalloy containing 90% tungsten, was quoted at $8.20 per pound of contained tungsten through April. The price was reduced to $7.75 per pound in May and remained at this level throughout the remainder of 1975.

The price of scheelite concentrate (calcium tungstate) for direct addition to steel melts was believed to be comparable with the data reported in table 7.

Table 7.—Monthly price quotations of tungsten concentrate in 1975

Month	Wolfram and scheelite: London market, pounds sterling per metric ton unit of WO_3, 65% basis		Equivalent quotations, dollars per short ton unit of WO_3, 65% basis [1]		
	Low	High	Low	High	Average [2]
January	£37.00	£39.50	$78.31	$85.34	$80.91
February	41.00	45.50	88.39	94.73	91.53
March	39.00	43.50	85.38	95.92	92.29
April	39.00	43.50	84.91	93.53	89.87
May	41.00	43.50	86.55	92.67	90.07
June	37.00	42.50	75.22	89.31	81.92
July	36.75	40.50	73.30	80.04	76.39
August	40.50	42.50	77.30	82.07	79.79
September	41.00	43.50	77.07	83.27	80.51
October	40.50	43.50	75.93	81.12	78.65
November	39.50	43.50	74.25	80.74	77.45
December	42.00	44.00	77.02	80.71	78.86

[1] Equivalent high and low quotations as reported in Metals Week from biweekly Metal Bulletin (London) data: Dependent upon the prevailing rate of currency exchange.
[2] Arithmetic average of weekly quotations. Equivalent 1975 average price, excluding duty, $83.19 per short ton unit.

FOREIGN TRADE

Exports.—Tungsten concentrate exports during 1975 increased 11% compared with that of 1974 and continued to represent excess material purchased from GSA stockpiles. Ferrotungsten exports rose 74% while exports of APT more than doubled. Exports of WC powder, primarily to Canada (30%), Mexico (19%), West Germany (10%), Italy (9%), and Iran (8%), decreased 61% during 1975.

Exports of unwrought tungsten metal and alloys in crude form, waste, and scrap increased 22% to 867,798 pounds, gross weight, valued at $2,129,247.. This material was shipped primarily to West Germany (68%), Belgium-Luxembourg (8%), and Canada (7%). Tungsten and tungsten alloy powder exports decreased 43% during the year to 784,635 pounds, gross weight, valued at $5,564,426. Israel (59%), Canada (8%), West Germany and Belgium-Luxembourg (7% each), Austria and Singapore (5% each), and the United Kingdom (3%) were the principal recipients.

Exports of tungsten and tungsten alloy wire decreased 41% to 159,098 pounds, gross weight, valued at $4,701,631 in 1975 and were shipped primarily to Canada (23%), Belgium-Luxembourg (15%), Israel (11%), and Japan (9%). Wrought tungsten and tungsten alloy exports fell 21% during the year to 229,489 pounds, gross weight, valued at $2,440,968. Most of these exports were shipped to West Germany (60%), Canada (12%), and to the United Kingdom and Belgium-Luxembourg (9% each).

Table 8.—U.S. exports of tungsten ore and concentrates, by country
(Thousand pounds and thousand dollars)

Country	1974			1975		
	Gross weight	Tungsten content [1]	Value	Gross weight	Tungsten content [1]	Value
Belgium-Luxembourg	--	--	--	1	(2)	4
Canada	10	5	28	--	--	--
France	110	57	199	119	62	388
Germany:						
East	275	142	338	--	--	--
West	1,258	649	2,468	1,223	631	3,875
Italy	--	--	--	7	3	40
Japan	65	33	92	--	--	--
Netherlands	392	203	1,237	1,191	614	3,756
Sweden	55	28	111	--	--	--
United Kingdom	136	70	362	11	6	19
Total	2,301	1,187	4,835	2,552	1,316	8,082

[1] Tungsten content estimated by multiplying the gross weight by a factor of 0.516 equal to 0.65 (to convert from 65% to 100% WO_3 basis) times 0.7931 (to convert from WO_3 to W basis).
[2] Less than ½ unit.

Table 9.—U.S. exports of ferrotungsten, by country

Country	1974			1975		
	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value
Canada	8,327	6,661	$34,952	32,906	26,325	$131,622
India	500	400	2,948	--	--	--
Japan	--	--	--	868	694	4,990
Mexico	10,572	8,458	177,061	--	--	--
Total	19,399	15,519	214,961	33,774	27,019	136,612

[1] Estimated tungsten content obtained by multiplying the gross weight by 0.80.

Table 10.—U.S. exports of ammonium paratungstate, by country

Country	1974			1975		
	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value
Australia	1,000	707	$18,950	--	--	--
El Salvador	308	218	1,123	--	--	--
Germany, West	--	--	163,470	44,700	31,585	$277,034
Jamaica	47,097	33,279	--	310	219	4,004
Japan	33,563	23,716	42,952	--	--	--
Mexico	2,031	1,435	8,125	--	--	--
Netherlands	2,100	1,484	7,665	143,500	101,397	643,683
New Zealand	--	--	--	183	130	2,300
Philippines	248	175	1,686	122	86	1,021
Zaire	73	50	1,244	--	--	--
Total	86,420	61,064	245,215	188,815	133,417	928,042

[1] Estimated tungsten content obtained by multiplying gross weight by 0.7066.

Table 11.—U.S. exports of tungsten carbide powder

Country	1974			1975		
	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value
Angola	1,450	1,131	$6,525	--	--	--
Argentina	7,252	5,656	37,997	1,582	1,234	$20,194
Australia	26,385	20,580	201,013	2,261	1,764	22,085
Austria	40,756	31,790	304,953	2,200	1,716	20,900
Belgium-Luxembourg	21,826	17,024	186,195	24,701	19,267	152,792
Belize	--	--	--	25	19	2,585
Brazil	15,255	11,899	75,722	11,089	8,649	83,137
Canada	771,616	601,860	2,214,896	340,524	265,609	2,377,549
Chile	2,919	2,277	17,850	254	198	3,500
Colombia	--	--	--	57	44	2,695
Costa Rica	2,592	2,022	16,238	400	312	5,100
Denmark	3,901	3,043	27,287	4,359	3,400	35,003
Finland	--	--	--	60	47	1,105
France	7,639	5,958	69,380	32,757	25,550	246,448
Germany, West	126,252	98,477	926,586	115,693	90,240	682,369
Indonesia	5,000	3,900	568	--	--	--
Iran	36,797	28,702	55,275	88,513	69,040	65,719
Ireland	7,430	5,795	76,508	550	429	5,087
Israel	83,869	65,418	516,840	38,771	30,241	320,807
Italy	59,043	46,054	598,970	105,137	82,008	604,614
Japan	241,883	188,669	1,805,176	4,361	3,402	40,168
Kuwait	--	--	--	100	78	1,394
Mexico	758,204	591,399	742,770	214,164	167,048	727,655
Netherlands	516,253	402,677	342,250	43,601	34,009	323,062
New Zealand	--	--	--	10,081	7,863	26,007
Nigeria	1,200	936	8,856	8,182	6,382	12,695
Norway	--	--	--	5,593	4,363	6,806
Oman	2,000	1,560	1,350	--	--	--
Peru	14,460	11,279	24,480	10,907	8,507	9,196
Philippines	--	--	--	6,189	4,827	56,746
Portugal	80	62	858	--	--	--
Qatar	2,500	1,950	5,000	1,800	1,404	2,084
Singapore	688	537	7,216	4,250	3,315	27,709
South Africa, Republic of	10,917	8,515	91,860	21,700	16,926	124,358
Southern Asia, n.e.s	--	--	--	4,000	3,120	1,902
Spain	25,837	20,153	196,358	14,312	11,163	161,700
Surinam	--	--	--	600	468	1,000
Sweden	335	261	4,351	8,080	6,302	76,503
Switzerland	37,784	29,472	308,237	14,528	11,332	164,704
Taiwan	486	379	5,146	1,125	878	12,790
Thailand	3,711	2,894	2,121	--	--	--
Trinidad and Tobago	--	--	--	318	248	2,389
Turkey	--	--	--	550	429	7,501
United Kingdom	93,347	72,811	547,301	8,833	6,890	98,002
Venezuela	6,533	5,096	12,557	100	78	1,095
Yemen Arab Republic	4,102	3,200	736	--	--	--
Total	2,940,302	2,293,436	9,439,426	1,152,307	898,799	6,537,155

[1] Estimated tungsten content obtained by multiplying gross weight by 0.78.

Table 12.—U.S. exports of tungsten and tungsten alloy powder

Country	1974			1975		
	Gross weight (pounds)	Estimated tungsten content [1] (pounds)	Value	Gross weight (pounds)	Estimated tungsten content [1]	Value
Argentina	53	42	$1,371	1,000	800	$10,706
Australia	12,582	10,066	80,254	1,170	936	10,508
Austria	35,411	28,329	231,996	39,463	31,571	267,249
Belgium-Luxembourg	27,514	22,011	146,968	54,623	43,699	377,315
Brazil	1,272	1,018	10,281	508	406	4,023
Canada	135,690	108,552	806,807	63,707	50,966	640,365
Denmark	--	--	--	1,097	878	9,000
Finland	22,044	17,635	114,681	9,038	7,230	65,041
France	3,061	2,449	29,100	1,048	838	15,193
Germany, West	53,105	42,484	361,092	51,905	41,524	123,341
India	2,075	1,660	10,028	38	30	1,010
Ireland	400	320	2,380	2,240	1,792	32,118
Israel	506,512	405,210	3,399,746	460,224	368,179	3,322,663
Italy	2,784	2,227	31,846	9,180	7,344	46,196
Japan	253,118	202,494	1,482,569	11,022	8,818	62,500
Mexico	7,575	6,060	40,649	3,410	2,728	33,139
Netherlands	110,000	88,000	375,800	--	--	--
Peru	158	126	1,750	--	--	--
Singapore	76,836	61,469	479,938	40,000	32,000	265,232
Spain	110	88	1,298	294	235	1,474
Switzerland	15,896	12,717	96,188	4,574	3,659	30,670
Taiwan	283	226	4,650	2,000	1,600	28,590
United Kingdom	120,789	96,631	742,622	27,194	21,755	208,331
Venezuela	1,375	1,100	16,168	900	720	9,762
Total	1,388,643	1,110,914	8,468,182	784,635	627,708	5,564,426

[1] Estimated tungsten content obtained by multiplying the gross weight by 0.80.

Imports.—Imports for consumption of tungsten concentrate fell 41% compared with that of 1974, and totaled nearly 6.6 million pounds of contained tungsten. The major suppliers were Canada (24%), Peru (13%), Bolivia (12%), Thailand (10%), and the Republic of Korea (8%).

Imports of WC during the year, primarily from West Germany (55%), Canada (25%), and Sweden (15%), decreased 1% and totaled 163,925 pounds of contained tungsten valued at $1,669,533. Imports of tungsten waste and scrap containing over 50% tungsten fell 59% during 1975 and totaled 68,959 pounds of tungsten valued at $294,139. This material was imported from the United Kingdom (26%), France (24%), West Germany (14%), Sweden (13%), Japan and Canada (8% each), and the Netherlands (7%). Imports of unwrought tungsten (except alloys) in lump, grain, and powder rose by a factor of almost eight to 201,437 pounds of contained tungsten valued at $1,865,507 and were received mainly from West Germany (71%) and Japan (25%). Wrought tungsten imports in 1975 decreased 48% and totaled 12,716 pounds valued at $1,198,891. Japan (39%) and Austria (30%) were the primary suppliers.

Imports of tungsten material classified as "metal-bearing materials in chief value of tungsten" fell 65% and totaled 70,991 pounds of contained tungsten valued at $280,186. Imports were received from Thailand (54%) and from the Republic of Korea (46%). Most of the material imported under this classification was believed to be synthetic scheelite. Imports of ammonium tungstate decreased 21% during the year and totaled 834,546 pounds of contained tungsten valued at $5,035,941. The Republic of Korea (67%) and Japan (25%) were the major suppliers.

Calcium tungstate imports in 1975, all from West Germany, increased 23% and totaled 37,819 pounds of contained tungsten valued at $576,533.

Table 13.—U.S. imports[1] of tungsten ore and concentrates, by country

(Thousand pounds and thousand dollars)

Country	1974			1975		
	Gross weight	Tungsten content	Value	Gross weight	Tungsten content	Value
Argentina	62	30	116	--	--	--
Australia	161	87	279	707	390	1,995
Belgium-Luxembourg	33	18	28	--	--	--
Bolivia	4,259	2,381	8,683	1,888	1,037	4,868
Brazil	523	297	1,173	336	187	1,012
Burma	392	205	563	308	160	815
Canada	3,202	1,648	6,494	3,815	1,585	7,769
Chile	--	--	--	15	8	40
China, People's Republic of	584	311	1,174	715	387	2,176
France	464	136	432	388	116	500
Germany, West	226	71	146	--	--	--
Guatemala	882	154	21	159	28	4
Japan	81	46	258	88	50	198
Korea, Republic of	741	419	1,778	927	530	2,832
Malaysia	298	170	372	120	70	178
Mexico	649	336	1,475	983	419	1,914
Netherlands	58	30	74	--	--	--
Peru	2,322	1,309	5,075	1,509	862	4,143
Portugal	2,779	1,635	6,940	335	197	1,164
Rwanda	863	462	1,058	--	--	--
South Africa, Republic of	224	114	352	83	27	68
South-West Africa, Territory of	--	--	--	88	50	195
Spain	176	95	298	24	14	66
Sweden	66	36	78	--	--	--
Taiwan	--	--	--	44	23	124
Thailand	3,234	1,655	5,732	1,255	673	3,033
Uganda	--	--	--	35	18	56
United Kingdom	94	53	257	33	19	107
Zaire	168	88	212	109	58	236
Total	22,541	11,786	43,068	13,964	6,908	33,493

[1] Data are "general imports;" that is, they include tungsten imported for immediate consumption plus material entering warehouses.

Table 14.—U.S. imports for consumption of tungsten ore and concentrates, by country

(Thousand pounds and thousand dollars)

Country	1974			1975		
	Gross weight	Tungsten content	Value	Gross weight	Tungsten content	Value
Argentina	38	19	70	--	--	--
Australia	161	87	279	707	390	1,995
Belgium-Luxembourg	33	18	28	--	--	--
Bolivia	3,749	2,065	7,389	1,433	787	3,839
Brazil	468	266	1,094	336	188	1,012
Burma	392	205	563	308	160	815
Canada	3,177	1,633	6,400	3,839	1,600	7,862
Chile	--	--	--	15	8	40
China, People's Republic of	584	311	1,174	569	310	1,752
France	464	136	432	388	116	500
Germany, West	226	71	146	--	--	--
Guatemala	--	--	--	[1]306	170	229
Japan	--	--	--	22	12	21
Korea, Republic of	644	364	1,478	898	514	2,744
Malaysia	298	170	372	120	70	178
Mexico	649	336	1,475	983	419	1,914
Netherlands	58	30	74	--	--	--
Peru	2,440	1,375	5,413	1,518	866	4,166
Portugal	2,779	1,635	6,940	335	197	1,164
Rwanda	863	462	1,058	--	--	--
South Africa, Republic of	224	114	352	83	27	68
Spain	176	95	298	24	14	66
Sweden	66	36	78	--	--	--
Thailand	2,991	1,527	5,114	1,217	629	2,901
Uganda	--	--	--	34	16	56
United Kingdom	94	53	257	33	19	107
Zaire	168	88	212	109	58	236
Total	20,742	11,096	40,696	13,277	6,570	31,665

[1] Adjusted by the Bureau of Mines.

Table 15.—U.S. imports for consumption of ferrotungsten, by country

Country	1974 Gross weight (pounds)	1974 Tungsten content (pounds)	1974 Value	1975 Gross weight (pounds)	1975 Tungsten content (pounds)	1975 Value
Austria	288,258	235,358	$938,373	158,989	131,609	$836,391
Brazil	50,706	35,606	103,202	--	--	--
Canada	64,955	51,223	204,921	--	--	--
France	143,299	111,371	415,003	44,092	34,058	225,703
Germany, West	--	--	--	22,046	18,122	107,393
Japan	--	--	--	44,092	35,331	204,528
Portugal	77,161	63,856	219,466	11,023	9,222	59,429
Sweden	54,625	38,965	116,024	--	--	--
United Kingdom	330,061	271,544	1,032,217	232,052	189,940	1,108,729
Total	1,009,065	807,923	3,029,206	512,294	418.282	2,542,173

Table 16.—U.S. imports for consumption of tungsten and tungsten carbide forms

(Thousand pounds and thousand dollars)

Year	Ingots, shot, bars, and scrap		Wire, sheets, and other forms, n.s.p.f.		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1973	730	1,431	703	3,516	1,433	4,947
1974	680	1,823	1,782	7,545	2,462	9,368
1975	488	2,548	1,460	8,556	1,898	11,104

Table 17.—U.S. import duties on all forms of tungsten

Tariff classification	Article	Rate of duty effective Jan. 1, 1976	
		Prevailing [1]	Statutory
601.5400	Tungsten ore	25¢ per pound on tungsten content.	50¢ per pound on tungsten content.
603.4500	Other metal-bearing materials in chief value of tungsten.	21¢ per pound on tungsten content and 10% ad valorem.	60¢ per pound on tungsten content and 40% ad valorem.
607.6500	Ferrotungsten	21¢ per pound on tungsten content and 6% ad valorem.	60¢ per pound on tungsten content and 25% ad valorem.
629.2500	Waste and scrap containing by weight not over 50% tungsten.	do	Do.
629.2600	Waste and scrap containing by weight over 50% tungsten.	10.5% ad valorem	50% ad valorem.
629.2800	Unwrought tungsten, except alloys, in lump, grain and powder.	21¢ per pound on tungsten content and 12.5% ad valorem.	60¢ per pound on tungsten content and 50% ad valorem.
629.2900	Unwrought tungsten, ingots and shot.	10.5% ad valorem	50% ad valorem.
629.3000	Unwrought tungsten, n.e.c	12.5% ad valorem	60% ad valorem.
629.3200	Tungsten alloys, unwrought, containing by weight not over 50% tungsten.	21¢ per pound on tungsten content and 6% ad valorem.	60¢ per pound on tungsten content and 25% ad valorem.
629.3300	Tungsten alloys, unwrought, containing by weight over 50% tungsten.	12.5% ad valorem	60% ad valorem.
629.3500	Wrought tungsten	do	Do.
416.4000	Tungstic acid	21¢ per pound on tungsten content and 10% ad valorem.	60¢ per pound on tungsten content and 40% ad valorem.
417.4000	Ammonium tungstate	do	Do.
418.3000	Calcium tungstate	do	Do.
420.3200	Potassium tungstate	do	Do.
421.5600	Sodium tungstate	do	Do.
422.4000	Tungsten carbide	21¢ per pound on tungsten content and 12.5% ad valorem.	60¢ per pound on tungsten content and 50% ad valorem.
422.4200	Other tungsten compounds	21¢ per pound on tungsten content and 10% ad valorem.	60¢ per pound on tungsten content and 40% ad valorem.
423.9200	Mixtures of two or more inorganic compounds in chief value tungsten.	do	Do.

[1] Not applicable to most centrally controlled economy countries.

WORLD REVIEW

The Committee on Tungsten of the United Nations Conference on Trade and Development (UNCTAD) met in late July 1975 to discuss methods of stabilizing world tungsten prices with a system of minimum and maximum prices. The Committee staff continued to canvass, tabulate, and publish detailed statistics on tungsten production, consumption, and trade in its quarterly bulletin, "Tungsten Statistics." [3] Copies of these reports are available from the United Nations Sales Section, Palais de Nations, CH-1211, Geneva 10, Switzerland, at a price of $3 each.

A meeting of several major world tungsten producers was held in La Paz, Bolivia, in April 1975 at which the Primary Tungsten Association (PTA) was established.[4] The PTA is comprised of the Associacion Nacional de Mineros Medianos, Cámara Nacional de Minería, and Corporación Minera de Bolivia (all from Bolivia); Beralt Tin and Wolfram (Portugal) SARL, and Minas de Borralha (Portugal); Minero Perú Commercial (Peru); Peko-Wallsend Ltd. (Australia); Mineração Acauan Indústria e Comércio S.A. (Brazil); Société Minière d'Anglade (France); Société Minière du Rwanda (Rwanda); Coto Minero Merladet S.A. and Compania Minera Santa Comba S.A. (Spain); and Société Zairoise Minière et Industrielle du Kivu (Zaire). The Siamerican Mining Enterprise Co., Ltd. (Thailand) and the China Council for the promotion of International Trade (the People's Republic of China) have observer status. PTA established its headquarters in London.

The PTA held a meeting in June prior to the intergovernmental meeting in Geneva of the UNCTAD Committee on Tungsten. The PTA's stated purpose was to develop a producer program for price stabilization and/or an international tungsten commodity agreement (such as the Lead-Zinc Study Group and the International Tin Council) to be presented before the Committee on Tungsten for UNCTAD endorsement and implementation.

Although PTA is an international group of tungsten-producing companies, as opposed to the UNCTAD Committee on Tungsten, which is an intergovernmental group, members from some countries attended both meetings.

U.S. tungsten producers were invited to attend meetings of the PTA but declined and cited U.S. antitrust regulations that prohibit participation in meetings to fix (stabilize) prices.

Comprehensive evaluations of the status of WC powder metallurgy in Poland and India were released during the year.[5]

[3] UNCTAD Committee on Tungsten (Geneva, Switzerland). Tungsten Statistics. V. 9, Nos. 1–4, 1975.

[4] Clarfield, K. W., S. Jackson, J. Keeffe, M. A. Nobel, and A. P. Ryan. Eight Mineral Cartels: The New Challenge to Industrialized Nations. (Published by Metals Week, a McGraw-Hill publication). 1975, pp. 169–172, 175–177.

[5] Nayar, H. S. Present Status of Powder Metallurgy in India. Internat. J. Powder Met. & Powder Tech., v. 11, No 2, April 1975, pp. 85–94.

Rutkowski, W. Powder Metallurgy in Poland. Internat. J. Powder Met. & Powder Tech., v. 11, No. 3, July 1975, pp 205–206.

Table 18.—Tungsten: World mine production by country
(Thousand pounds of contained tungsten) [1]

Country	1973	1974	1975 p
North America:			
Canada [2]	3,680	2,822	2,369
Guatemala	r 95	14	2
Mexico	767	681	611
United States	7,575	7,381	5,588
South America:			
Argentina	183	117	e 130
Bolivia [3]	4,264	4,471	5,476
Brazil [4]	r 2,319	2,189	2,496
Peru	1,896	1,519	1,283
Europe:			
Czechoslovakia e	175	175	175
France	r 1,547	1,307	e 1,900
Portugal	3,336	3,280	3,082
Spain	690	654	734
Sweden	478	366	e 310
U.S.S.R. e	16,300	16,800	17,200
United Kingdom	[5] 44	[5] 35	e 35

See footnotes at end of table.

Table 18.—Tungsten: World mine production by country—Continued

(Thousand pounds of contained tungsten) [1]

Country	1973	1974	1975 [p]
Africa:			
Nigeria	3	([6])	[e] 1
Rhodesia, Southern [7]	339	201	84
Rwanda	666	553	937
South Africa, Republic of	1	--	--
Southwest Africa, Territory of [8]	49	--	16
Tanzania	2	1	[e] 1
Uganda [e]	240	240	240
Zaire	532	432	548
Asia:			
Burma	1,133	750	538
China, People's Republic of [e]	17,600	18,700	19,800
India	[r] 28	27	[e] 60
Japan	[r] 1,916	1,785	1,694
Korea, North [e]	[r] 4,740	[r] 4,740	4,740
Korea, Republic of	4,504	5,046	5,299
Malaysia	[r] 298	289	233
Thailand	[r] 5,295	4,486	3,609
Oceania:			
Australia	[r] 2,915	2,439	3,379
New Zealand	2	9	[e] 10
Total	[r] 83,612	81,509	82,580

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Conversion factors: WO_3 to W, multiply by 0.7931; 60% WO_3 to W, multiply by 0.4758.

[2] Producers' shipments; actual production data are not officially reported, but available company figures indicate a substantial difference between actual output and shipments in some years.

[3] Data presented are sum of production reported by COMIBOL and exports credited to medium and small mines.

[4] Figures exceed those reported in official Brazilian sources, these sources do not include production by small mines, which in aggregate apparently are substantial.

[5] Revised from zero.

[6] Less than ½ unit.

[7] Production from Beardmore mine only, and are for the year ended September 30 of that stated.

[8] Data are for the South West Africa Co. Ltd. only, and for the year ended June 30 in the case of 1973. The 1975 figure covers the year ended December 31.

Table 19.—Tungsten: World concentrate consumption, by country

(Thousand pounds of contained tungsten)

Country [1]	1973	1974	1975 [p]
Actual consumption:			
Australia	88	88	[e] 88
Austria	2,469	2,310	2,006
Czechoslovakia [e]	[r] 2,866	[r] 2,745	2,700
France	3,854	3,926	3,058
Japan	[r] 7,535	6,466	3,765
Portugal	703	831	708
Sweden	3,223	3,702	3,452
United Kingdom	[r] 7,983	6,116	5,831
United States	15,386	16,298	14,012
Apparent consumption, excluding stock variations: [2]			
Argentina	115	150	110
Belgium-Luxembourg	346	313	298
Brazil	562	386	375
China, People's Republic of [e 3]	4,500	4,500	4,600
Germany:			
East [e 3]	650	600	550
West	6,931	4,068	2,363
Hungary [3]	50	50	50
India	[r] 335	326	310
Italy	198	315	165
Korea, North [e 3]	3,500	3,500	3,500
Korea, Republic of [e 4]	[r] 500	1,400	1,500
Netherlands	1,971	4,491	4,165
Poland	5,148	3,730	3,549
South Africa, Republic of [e]	573	[r] 573	550
Spain	[r] 571	231	90
U.S.S.R	14,800	14,900	14,900
Total	[r] 84,857	82,015	72,695

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition, the following countries may consume tungsten concentrate, but specific data are not available: Bulgaria, Canada, Denmark, Finland, Israel, Norway, Romania, Switzerland, and Yugoslavia.

[2] Production plus imports minus exports.

[3] Estimated by author.

[4] Data represents tungsten concentrate consumed to make ammonium paratungstate at APT plant adjacent to Sangdong mine and mill.

Primary Source: UNCTAD Committee on Tungsten quarterly reports "Tungsten Statistics" and Annual Company Reports.

Australia.—King Island Scheelite, Ltd., a subsidiary of Peko-Wallsend Ltd., continued to account for most of the Australian tungsten concentrate production from Scheelite ore grading 0.57% WO_3 at its underground operation on King Island, Tasmania.[6] Other minor reported tungsten production was from wolframite ores in Tasmania, Queensland, New South Wales, and Victoria. Some tungsten deposits also exist in Western Australia. At yearend, tungsten resources at King Island were increased to 7.7 million tons grading 0.8% WO_3.

Bolivia.—Empresa Nacional de Fundiciones (ENAF) evaluated the possibility of constructing a tungsten processing plant in Viacha about 10 miles south of La Paz.[7] Initial plans indicate that the plant would be operated as a joint venture between ENAF and International Mining Co. with technical assistance from the United States.

Brazil.—Mineração Tomaz Salustino SA continued to mine tungsten concentrate in Rio Grande do Norte. Brejui Mineração e Metallurgia SA was formed to extract synthetic scheelite from tungsten mine tailings. A plant was scheduled to be constructed in 1976 to process the tailings.

A review of a detailed report on the Brazilian ferroalloy industry by Associação Brasileira de Produtores de Ferro Ligas (ABRAFE), including long-term ferroalloy forecasts, was published.[8] The review indicated that Brazil was close to self-sufficiency in the production of ferrotungsten and would continue in this position into the 1980's. Brazil may even become a net exporter in the future.

Canada.—Tungsten concentrate produced by the Canada Tungsten Mining Corp. Ltd. (CTMC) at Tungsten, Northwest Territories, decreased 8% compared with that of 1974 and totaled 2.6 million pounds of tungsten in 1975.[9] No byproduct copper concentrate was recovered during the year. The overall WO_3 recovery decreased slightly to 71.1% compared with 71.4% in 1974. The concentrator was operational 92.7% of the time and averaged 490 tons per day.

Because of metallurgical problems created by the presence of talc in the ore, scheelite recovery was lower than anticipated. Many circuit adjustments were made during the year, and improved recovery was expected in 1976. Reserves totaled 4,347,000 tons of scheelite ore grading 1.6% WO_3 and 0.23% Cu at yearend.

At Tungsten, work was started on an extension to the powerhouse and on construction of a new assay laboratory. Sections of the main access road, damaged during the severe winter of 1974, were upgraded and drainage ditches were dug.

Operations at CTMC's tungsten leach plant at North Vancouver, British Columbia, were satisfactory with an overall recovery rate of 98.3%.

Korea, Republic of.—During 1975, Korea Tungsten Mining Co., Ltd. (KTMC), continued to be the country's major tungsten producer and accounted for over 92% of the total production of the Republic of Korea. At yearend, KTMC was owned 8.7% by the Republic of Korea Government (down from 15.5% in mid-1975). Data on Korean production and stocks of tungsten concentrate and estimated production of APT are indicated in the following tabulation for 1975:

[6] Peko-Wallsend Ltd. (Sydney, Australia). Annual Report 1974–75. 32 pp.
[7] Mining Magazine. Tin and Antimony Smelting at Vinto in Bolivia. V. 134, No. 5, May 1976, p. 369.
[8] Metal Bulletin Monthly (London). South America: Brazil's Ferro-Alloy Aims. No. 50, February 1975, pp. 29–31.
[9] Canada Tungsten Mining Corp. Ltd. (Toronto, Canada). 1975 Annual Report. 9 pp.

Company	Short tons (contained tungsten)		
	Concentrate		APT production [e]
	Production	Stocks	
Chongpung mine	18	NA	--
Daewha mine	11	NA	--
Korea Tungsten Mining Co.: Sangdong mine	2,481	NA	1,100
Okbang Mining Co., Ltd	48	NA	--
Samyang mine	59	NA	--
San-Nae mine	49	NA	--
Other miscellaneous mines	29	NA	--
Total	2,695	390	1,100

[e] Estimate. NA Not available.

Portugal.—Production of tungsten by the major Portugese tungsten producer, Beralt Tin and Wolfram (Portugal) SARL, at the Panasqueira mine decreased 5% to slightly less than 2 million pounds of contained tungsten in 1975 due to absenteeism and a brief mine shutdown due to storm damage in December.[10] Production was also affected by reduction in allowable working hours for underground workers introduced by the Secretary of State for Labor. The availability of local labor, following an influx of immigrants from Angola and Mozambique, improved, and contracts with Cape Verdean laborers were generally not renewed.

Operation of the preconcentration plant at Barroca Grande and the mill at Rio continued to operate at satisfactory tungsten recoveries. A new byproduct copper circuit at the Rio mill became operable in October.

Rhodesia, Southern.—The Messina (Transvaal) Development Co., Ltd., conducted prospecting work on a low-grade tungsten ore zone on its Beardmore claims during the year and located some new mineralization, but no new ore bodies were identified.[11] The sand retreatment dumps were depleted in June, and in July the crushing and grinding plants at the Beardsmore mine and mill were recommissioned to treat lower grade ores. A total of 13,000 tons of slimes and 30,000 tons of sands were reprocessed, and 6,200 tons of ore were milled. Tungsten recovery remained satisfactory and 120 tons of concentrate containing 44% WO_3 were produced.

South-West Africa, Territory of.—The South West Africa Company Ltd. announced plans to reopen its tin-tungsten operation at Brandberg West. Rehabilitation work on the plant, located 150 miles northwest of Windhoek, began in the latter part of 1974. By yearend 1974, 8,000 tons of ore had been stockpiled, reopening of the property was almost completed, and trial milling operations began.

Recent exploration drilling adjacent to the Brandberg West mine indicated the presence of about 660,000 tons of additional ore. Total deposits in this area are estimated at 7.3 million tons of ore containing 0.24% combined tin and tungsten.

Nord Resources Corp. continued to operate the Krantzburg scheelite mine and mill about 100 miles northwest of Windhoek and sold WO_3 concentrate to South Africa, the United States, and Western European countries during 1975.[12]

Nord drilled a new higher grade adjacent ore zone that should come into production in 1976. In addition, Nord has a larger lower grade ore zone in one area that, if worked, could be developed into a a large-scale mining operation.

Turkey.—Initial production of tungsten concentrate from Etibank's scheelite mine at Uludag near Bursa was delayed by fire in February that severely damaged the mine infrastructure. Procurement and installation of new shoring and equipment progressed, and the mine operation was scheduled to start in late 1976. Production in 1977 was expected to be about 75% of the annual rated capacity of 3,300 tons of tungsten concentrate containing about 67% WO_3.

U.S.S.R.—The Sandvik Group, headquartered in Sandviken, Sweden, signed an agreement with Stankoimport, the U.S.S.R.'s foreign trade organization, to establish a $34 million cemented carbide cutting tool plant in Russia.

Sandvik's participation will include supplying machines, equipment, and spare parts; supervising installation work; and training the personnel. The facility to be built in the Moscow district was scheduled to begin production of cemented carbide indexable inserts for cutting tools in early 1976. For several years, the Sandvik Group has also been supplying tungsten carbide tools for the Soviet auto/truck industry.

Development of an open pit tungsten-molybdenum deposit at the Tyrny-Auz complex in North Caucasus continued during the year. Exploration of a new tungsten deposit in Buryat A.S.S.R. continued throughout 1975.

TECHNOLOGY

Methods of encasing a fissionable enriched uranium oxide fuel were developed in which successive emitter layers of molybdenum (Mo), tungsten (W), and Mo-W were used. Recent developments in WC applications have included the use

[10] Beralt Tin and Wolfram Ltd. (London). 1975 Annual Report. 20 pp.

[11] The Messina (Transvaal) Development Co. Ltd. (Johannesburg, South Africa). 1975 Annual Report. 31 pp.

[12] Cruft, E. F. Tungsten in South-West Africa. Presentation to New York Society of Security Analysts. Aug. 22, 1975.

of tin-coated WC, WC catalysts, and hydrostatically compacted tungsten carbide-cobalt (WC-Co) powders.[13]

The results of a geochemical survey of the overburden of the Tungsten Queen mine in North Carolina, indicated that trace-element values in soil are related to major underlying tungsten mineralization.[14]

New ways to apply the proprietary processing operation of Dynamet Technology Inc. to the development of tungsten carbide cutting tools by isostatic pressing techniques were evaluated.[15]

Thin tungsten films were developed with a microscopic dendritic surface structure that may open a new market for tungsten in solar energy systems. International Business Machines Corp. (IBM) scientists discovered that vapor-deposited tungsten captures 96% of the sunlight that reaches the film and can retain heat at operating temperatures of 925° F. This highly efficient collecting surface could stimulate interest in solar heating technology.[16]

Studies of the morphological changes that occurred during the reduction of WO_3 to W metal powder indicated an initial reduction to large platelike whiskers of $WO_{2.72}$.[17] The formation of whiskers of $WO_{2.72}$ is the controlling step in determining the final particle size of tungsten powder.

WC rolls have been developed that are a great improvement over chilled iron or steel rolls.[18] Thermal fatigue laboratory tests and experience from other carbide applications indicated that a coarse WC grain grade was superior to medium or fine grain grades in hot rolls.

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[13] Climax Molybdenum Co. Tungsten News. November 1975, 30 pp.

[14] Gair, J. E., J. F. Windolph, Jr., and N. A. Wright. Preliminary Results of Geochemical Soil Survey, Hamme Tungsten District, North Carolina. Geol. Survey Circ. 711, 1975, 19 pp.

[15] Larson, R. Powder Metal Production of Cutting Tools is Tested. Am. Metal Market, v. 82, No. 94, May 14, 1975, pp. 4, 11.

[16] Iron Age. Techfront: Tungsten Finds a New Role in Solar Energy. V. 216, No. 12, Mar. 24, 1975, p. 43.

[17] Sarin, V. K. Morphological Changes Occurring During Reduction of WO_3. J. Mater. Sci., v. 10, No. 4, April 1975, p. 593–598

[18] Edsmar, K. Experience With Carbide Rolls for Hot Rolling of Rods. Iron and Steel Eng., v. 52, No. 4, April 1975, pp. 80–88.

Uranium

By James H. Jolly [1]

Domestic uranium mine production (in terms of U_3O_8) was lower in 1975 owing principally to the mining of lower grade ores. Mining activity continued high and the gross ore tonnage produced was greater than that in 1974. The tonnage of ore milled increased significantly; however, the production of uranium increased less than 1% owing to the lower grade of ore milled. Fifteen conventional mills and 2 additional plants for recovery of uranium from in situ leach solutions and from phosphoric acid operated in 1975, compared with 14 conventional mills operating in 1974.

Although mine and mill production continued near the previous year's level, production was expected to increase rapidly in the next few years. A number of major new mines and associated mills were planned or under construction primarily in New Mexico and Wyoming, which together accounted for about three-fourths of the total domestic mine production. Several operating mills were expanded to increase capacity, and others were undergoing modernization and expansion. Increased emphasis was placed on recovering uranium by solution mining; one operation in Texas started commercial production in 1975 and others were planned. The commercial recovery of uranium from Florida phosphate also began in 1975; additional recovery modules were planned and a central processing plant was under construction.

Exploration for uranium continued on a large scale, although the success ratio was unimproved. Higher uranium prices increased interest in the development of lower grade resources. According to the Energy Research and Development Administration (ERDA),[2] reserves at forward costs to $30 per pound of U_3O_8 increased by 40,000 tons whereas lower cost reserves ($8 and $10 per pound of U_3O_8) declined owing to the relatively steep rate of inflation affecting production costs. The ERDA office at Grand Junction, Colo., continued its national uranium resource evaluation program, which is designed to assess the country's potential uranium resources.

In other sectors of the nuclear fuel cycle, legislation to aid the development of private uranium enrichment facilities and to build an additional Government diffusion plant was proposed. Programs to improve operations and increase capacity at the three Government enrichment plants continued. Although a nuclear fuel reprocessing facility was nearing completion, licensing problems were expected to delay startup for several years. Waste management continued as a major concern. Long-term storage in stable geological formations continued to be the favored means of disposal.

Shortage of investment capital, concern for reactor safety, plutonium, radioactive waste, and energy conservation practices caused further delays in commercial nuclear power development. Despite these adverse factors, the industry continued to move forward. Three powerplants became operable in 1975, and 11 orders for new plants were placed. Nuclear powerplants generated about 9% of the nation's electrical energy in 1975, up from 6% in 1974. Nuclear power continued to be attractive from the economic standpoint when compared with power generation using coal and oil.

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[1] Physical scientist, Division of Nonferrous Metals.

[2] Established January 19, 1975 under the Energy Reorganization Act of 1974, which abolished the U.S. Atomic Energy Commission (AEC). The Nuclear Regulatory Commission (NRC), which assumed AEC's responsibilities in the licensing and regulatory area, was established at the same time.

Table 1.—Salient uranium statistics
(Short tons U_3O_8 unless otherwise specified)

	1971	1972	1973	1974	1975
Production:					
Domestic:					
Mine: [1]					
Ore ---- thousand tons --	6,279	6,418	6,537	r 7,116	7,365
Content of ore ----	12,907	13,667	13,588	12,413	12,300
Average grade of ore percent U_3O_8 --	0.205	0.213	0.208	0.174	0.164
Recoverable [2] ----	12,260	12,880	12,901	11,614	11,439
Value [3] ---- thousands --	$151,996	$162,272	$167,718	r $192,560	$281,388
Mill, concentrate [4] ----	12,273	12,900	13,235	11,528	11,600
World e 5 ----	23,903	r 25,647	r 25,797	r 24,576	26,443
Domestic delivery of concentrate, private ----	12,800	11,600	12,100	11,900	12,500
Imports, concentrate ----	942	2,329	5,605	1,835	1,226
Reserves [6] ---- thousand tons --	333	337	340	315	270
Employment [7] ---- number of persons --	7,373	6,403	6,595	7,293	9,672

e Estimate. r Revised.
[1] Receipts at mills; excludes uranium from leaching operations, mine waters, and refinery residues.
[2] Based on mill recovery factors.
[3] Market value based on recoverable U_3O_8 content and estimated average price.
[4] Includes marketable concentrate from leaching operations.
[5] Market economies only.
[6] At yearend; maximum forward cost of $10 per pound U_3O_8.
[7] In exploration, mining, and milling, at yearend.

Principal source: Energy Research and Development Administration.

Exploration and Reserves.—According to an ERDA survey,[3] 86 companies reported expenditures of $122 million on uranium exploration activities in 1975. Foreign interests in 15 companies accounted for about 11% or $13 million of total expenditures. At yearend, 71 companies reported uranium exploration holdings of 11.8 million acres, 31% more than in 1974. During 1975, 3.8 million acres were acquired at a cost of $16.7 million. The cost per acre ranged from less than 10 cents to more than $60, averaging $4.80.

In 1975, 55,900 surface holes were drilled by 96 companies using an estimated 244 drill rigs. Total exploration and development drilling footage was about 18% more than that of 1974. Exploration costs, including drilling, access roads, site preparation, geologic and technical work, sampling, and logging ranged from $1 to $16 per foot averaging $2.90 per foot, a 40% increase over costs in 1974.

[3] Energy Research and Development Administration. Uranium Exploration Expenditures in 1975 and Plans in 1976–77. GJO–103(76), Grand Junction, Colo., May 1976, 10 pp.

Table 2.—Surface drilling for uranium

	1974	1975 e
Type of drilling: [1]		
Exploration thousand feet --	14,720	16,200
Development ---- do ----	6,840	9,800
Total ---- do ----	21,560	26,000
Number of holes:		
Exploration ----	27,400	34,300
Development ----	12,300	21,600
Total ----	39,700	55,900
Average depth per hole:		
Exploration ---- feet --	537	472
Development ---- do ----	556	454
Total average -- do ----	543	465

e Estimate.
[1] Does not include claim validation drilling or underground long hole and diamond drilling.

Source: Energy Research and Development Administration.

Table 3.—Distribution of drilling, by State

State	1974 Total footage (millions)	1974 Approximate percent of total	1975 Total footage (millions)	1975 Approximate percent of total
Wyoming	11	50	12	47
New Mexico	5	22	6	22
Texas	3	13	3	13
Colorado	1	4	1	4
Utah [1]	--	--	2	7
Other [2]	2	11	2	7
Total	22	100	26	100

[1] Included in "Other" in 1974.
[2] Includes Alaska, Arizona, California, Idaho, Nevada, Nebraska, North Dakota, Oregon, Oklahoma, South Dakota, Washington, and Eastern United States.

Source: Energy Research and Development Administration.

ERDA reported increases in overall domestic uranium reserves in 1975 but estimates of reserves recoverable at a cost of $10 or less per pound of U_3O_8 declined significantly owing to the affects of inflation and to reevaluation of data for certain deposits. There were 573 properties having reserves at $10 per pound of U_3O_8 and 1,819 properties having reserves at $30.

Table 4.—Domestic ore reserves at various estimated costs

Cutoff costs (per pound U_3O_8)	Tons of ore (millions) 1974	Tons of ore (millions) 1975	Average grade (percent) 1974	Average grade (percent) 1975	Tons of U_3O_8 1974	Tons of U_3O_8 1975
$10	167	156	0.19	0.17	315,000	270,000
$15 [1]	343	329	.12	.13	420,000	430,000
$30 [1]	NA	774	NA	.08	600,000	640,000

NA Not available.
[1] Includes lower cost reserves.

Source: Energy Research and Development Administration.

Table 5.—Domestic resource estimates
(Thousand tons U_3O_8)

Cost category (per pound of U_3O_8)	Probable	Possible	Speculative
$10	440	420	145
$15 [1]	655	675	290
$30 [1]	1,060	1,270	590

[1] Includes lower cost resources.

Source: Energy Research and Development Administration.

New Mexico and Wyoming continued to be the leading States in uranium reserves with a combined total of 83% of the $10 reserves and 85% of the $15 reserves. ERDA estimated that yearend reserves, by State, at a cost of $10 per pound of U_3O_8 were as follows:

State	Tons of ore (millions)	Grade (percent U_3O_8)	Tons of U_3O_8	Percent of total tons of U_3O_8
New Mexico	57.2	0.26	151,000	56
Wyoming	62.6	.12	[1]73,000	27
Texas	19.8	.08	[1]15,000	6
Colorado and Utah	6.3	.30	19,000	7
Other [2]	10.3	.11	12,000	4
Total	156.2	.17	270,000	100

[1] Includes low-grade reserves recoverable at $10 per pound by solution mining.
[2] Arizona, California, North Dakota, South Dakota, and Washington.

Source: Energy Research and Development Administration.

ERDA continued to expand its National Uranium Resource Evaluation (NURE) program to assess potential uranium resources throughout the United States, including Alaska. Contract aerial radiometric reconnaissance surveys were expected to cover 125 areas consisting of 741,000 line miles by 1980, using computerized, high-sensitivity, gamma-ray spectrometers and magnetic detectors. The resource program also included hydrogeochemical studies and the sampling of alluvial sediments. Participants included ERDA's national laboratories, private companies, universities, State agencies, the U.S. Geological Survey, and the Environmental Protection Agency. Data on the airborne and geochemical studies are placed on open file following completion of each survey. To meet the expanding program, NURE funds were increased from $5.7 million in fiscal 1974 to $14 million in fiscal 1975.

In August, Bendix Field Engineering Corp. became the onsite contractor for ERDA's Grand Junction Office. As such, Bendix assumed responsibility for the operation of the Grand Junction facility and for programs related to estimating national resources of uranium, identifying favorable areas for uranium exploration, developing and evaluating improved uranium exploration assessment and production technology, and administering leases on mineral lands under ERDA control.

PRODUCTION

Mine.—Gross uranium ore output was higher than that of 1974, but the average ore grade and recoverable U_3O_8 were lower. ERDA data indicated production, by State, as follows:

State	Mine production [1]	
	Ore (thousand tons)	U_3O_8 content (tons)
New Mexico	2,985	5,500
Wyoming	2,589	3,700
Other [2]	1,791	3,100
Total	7,365	12,300

[1] Does not include output of approximately 200 tons of U_3O_8 from mine waters, leaching operations, and recovery from phosphate rock processing.
[2] Colorado, Texas, Utah, and Washington; combined to avoid disclosing individual company confidential data.

About 55% of the total production of 12,300 tons of U_3O_8, was from open pit mines; 43%, from underground mines; and 2%, from other sources. There were 121 underground mines, 23 open pits, and 25 miscellaneous sources in 1975, compared with 123 underground mines, 31 open pits, and 19 miscellaneous operations in 1974.

Several large new mines were planned or under development mainly in New Mexico and Wyoming. Gulf Mineral Resources, Inc. (GMR), a division of Gulf Oil Corp., continued development on the largest and deepest uranium mine in the United States near Mt. Taylor in New Mexico. The ore body, which lies at a depth of 3,500 feet, was estimated to have reserves of 100 million pounds of U_3O_8. At yearend the 14-foot-diameter service shaft was sunk to a depth of 700 feet. Work on the main shaft began in December and was expected to be completed in 1978 at which time underground development was to begin. Commercial production was scheduled for 1981. GMR was also planning to develop its smaller and shallower uranium reserves at Mariano, N. Mex. Shaft sinking was expected in 1976 with production in 1977.

Development work at the Johnny M mine, a joint venture of Ranchers Exploration & Development Corp. (RED) and HNG Oil Co., was completed during the year. Production was expected in early 1976 at a mining rate of 800 tons ore per day. In the Church Rock area near Gallup, N. Mex., Kerr-McGee Nuclear Corp. (KMN) and United Nuclear Corp. (UNC) also had mines under development.

Phillips Petroleum Co. announced a significant uranium discovery near Crownpoint in McKinley County, N. Mex. Drilling indicated an estimated 25 million pounds of U_3O_8 in 7 million tons of ore at depths between 3,000 and 3,500 feet. Feasibility studies were underway at yearend; however, the company estimated that production could not start before 1981.

Rocky Mountain Energy Co., a joint venture of Union Pacific Corp. and Mono Power Co., planned to construct a mine-mill complex at Bear Creek, 65 miles northeast of Casper, Wyo. Construction of a 1,000-ton-per-day mill was scheduled to begin in 1976, subject to licensing by the Nuclear Regulatory Commission (NRC). Construction was expected to start in mid-1977.

Utah International, Inc. planned to develop nine pits at its Green Mountain uranium mine, located 15 miles southeast of Jeffrey City, Wyo. The company expected to start stripping operations and mine construction by mid-1976. Development of the pits, which was to involve the removal of about 100 million cubic yards of overburden, was not expected to be completed until the mid-1980's.

Development drilling in 1975 by RED substantially extended reserves (estimated at 800,000 pounds of U_3O_8) at its Small Fry mine near Moab, Utah. RED was readying the mine for production at a rate of 250 tons per day.

Atlantic Richfield Co. (50%), Dalco Oil Co. (25%), and United States Steel Corp. (25%) began commercial production at the in situ leaching operation near George West, Tex., in April.[4] Production capacity was 250,000 pounds of U_3O_8 per year; however, plans called for expansion to 1 million pounds per year after operating experience was gained.

Byproduct Uranium.—An estimated 6 million pounds of U_3O_8 were considered recoverable annually by 1979 from wet process phosphoric acid operations that use Florida phosphate rock.[5]

Uranium Recovery Corp. (URC), a subsidiary of UNC, expected to complete its 1,000-ton-per-year central uranium finishing plant at Mulberry, Fla., in early 1976 and was preparing to operate its first uranium recovery module in 1976 at the W. R. Grace & Co. (WRG) phosphoric acid facility at Barstow, Fla.[6] URC has contracted to install three additional modules, two at a new phosphoric acid plant owned by International Mineral & Chemical Corp., 10 miles west of Mulberry, and another to be added to the WRG plant in 1977. When these four units are completed, URC was expecting to recover about 1.3 million pounds of U_3O_8 per year. Other programs to recover uranium from wet process phosphoric operations were in advanced pilot plant stages, but no commitments for construction of commercial plants were announced. Companies involved in these efforts were Westinghouse Electric Corp. and Gardinier, Inc., at Gardinier's Tampa, Fla., plant; Freeport Minerals Co. at its Uncle Sam, La., plant; and Gulf Oil and Chemicals Corp. at Agrico Chemical Co.'s plant in South Pierce, Fla.

Mill.—Output of U_3O_8 in concentrate was slightly higher than in 1974 owing mainly to higher mill throughput. Fifteen conventional mills plus 2 additional processing plants were operating at the end of 1975, compared with only 14 conventional mills in 1974. The 15 mills operated at the highest average rate per mill ever attained (1,400 tons of ore per day), and the total ore processed, 7.4 million tons, was exceeded only by that of the record years of 1960 and 1961 when more than 25 mills were processing ore. Despite the high ore processing rate, production increased only slightly owing to the processing of lower grade mill feed. The mills operated at about 80% of capacity and mill recovery improved marginally, averaging slightly less than 94%. At yearend, total operable milling capacity was 28,450

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[4] Chemical Week. New Solution for Those Who Dig Uranium. V. 116, No. 18, Apr. 30, 1975, p. 29.

[5] Facer, J. F., Jr. Production Statistics. Paper in Proc. of Uranium Industry Seminar Oct. 7–8, 1975. Energy Research and Development Administration, GJO–108 (75), pp. 151–158.

[6] United Nuclear Corp. 1975 Annual Report, p. 8.

tons of ore per day, an increase of 2,650 tons over that of 1974.

In 1975, Utah International, Inc. raised the capacity of its Shirley Basin, Wyo., mill from 1,200 tons per day to 1,800 tons per day primarily to enable the plant to process lower grade ores without reducing the output of uranium. Atlas Corp. was adding a new uranium-vanadium recovery circuit to its Moab, Utah, mill. The new facilities, which permit the processing of carnotite ores, were expected to be fully onstream in early 1976. The annual production of the renovated mill was to be 1 million pounds of U_3O_8 and 3 million pounds of vanadium.[7] Western Nuclear Inc. was modernizing and expanding its Jeffrey City, Wyo., mill and was to resume operations in 1976. The expansion program was scheduled to be completed in 1979, at which time the annual capacity of the mill was planned at 2 million pounds of U_3O_8.[8]

[7] Engineering and Mining Journal. Renovated Atlas Mill Will Produce Uranium, Vanadium, and Copper. V. 177, No. 1, January 1976, pp. 87–91.
[8] Skillings' Mining Review. Uranium Mill Expansion. V. 64, No. 27, July 5, 1975, p. 11.

Table 6.—Domestic uranium mill statistics in 1975
(Short tons U_3O_8 unless otherwise specified)

Operating mills, yearend ... number	15
Average daily milling rate ... tons of ore	23,000
Mill receipts, content of ore	12,100
Mill feed:	
Content of ore	12,200
Other [1]	200
Total	12,400
Recovery rate ... percent	93.5
Production	11,600
Shipments	13,200
Stocks:	
Content of ore, Jan. 1, 1975	300
Content of ore, Dec. 31, 1975	200
Concentrate, Jan. 1, 1975	4,300
Concentrate, Dec. 31, 1975	2,700
In process:	
Concentrate, Jan. 1, 1975	400
Concentrate, Dec. 31, 1975	400

[1] Concentrate from leaching operations, mine waters, refinery residues, recycled tailings, and cleanup.

Source: Energy Research and Development Administration.

Table 7.—Operating domestic uranium milling and ore processing companies and capacities in 1975

Company	Plant location	Nominal capacity (tons of ore per day)
The Anaconda Company	Grants, N.M	3,000
Atlantic Richfield Co	George West, Tex	(1)
Atlas Corp	Moab, Utah	1,000
Conoco-Pioneer	Falls City, Tex	1,750
Cotter Corp	Canon City, Colo	450
Dawn Mining Co	Ford, Wash	400
Exxon Nuclear Co., Inc	Powder River Basin, Wyo	3,000
Federal-American Partners	Gas Hills, Wyo	950
Kerr-McGee Nuclear Corp	Grants, N.Mex	7,000
Rio Algom Ltd	LaSal, Utah	700
Union Carbide Corp	Uravan, Colo	1,300
Do	Gas Hills, Wyo	1,200
United Nuclear-Homestake Partners	Grants, N.Mex	3,500
Uranium Recovery Corp	Mulberry, Fla	(2)
Utah International, Inc	Gas Hills, Wyo	1,200
Do	Shirley Basin, Wyo	1,800
Western Nuclear, Inc	Jeffrey City, Wyo	1,200
Total		28,450

[1] Uranium obtained by solution mining.
[2] Uranium recovered from phosphoric acid.

Source: Energy Research and Development Administration.

Uranium Hexafluoride (UF_6).—Two commercial operations—the Allied Chemical Corp. plant at Metropolis, Ill., and the Kerr-McGee Corp. (KMC) plant at Sequoyah, Okla.—produced UF_6 during 1975. The conversion capacities of the Allied Chemical Corp. plant and the Kerr-McGee Corp. plant were 15,430 tons and 5,510 tons of uranium per year, respectively. KMC began an expansion program to double conversion capacity by the end of 1977. According to ERDA, the available annual conversion capacity of 26,450 tons of uranium after the KMC expansion will be sufficient until about 1979.

Beker Industries Corp. announced plans in October to build a plant at Carlsbad, N. Mex., for the conversion of uranium to UF_6. The company estimated it would take 3 years to construct the plant after all economic and technical studies were completed. The plant was expected to cost $100 million and was to have a capacity of 23,500 tons of UF_6 per year.[9]

In June ERDA announced that holders of fixed commitment enrichment contracts could terminate or adjust separative work schedules. This offer was made primarily because utilities from late 1974 were experiencing slowed load growths and problems in financing new power projects, difficulties that caused marked reductions in actual requirements for enrichment services. Out of a total of 137 domestic fixed commitment contracts, holders of 96 contracts elected to slip separative work delivery schedules an average of 23 months, 21 adjusted schedules, and 4 terminated contracts. Of the foreign contracts, out of a total of 112 fixed commitment and conditional contracts, 54 delayed separative work commitments an average 29 months, 4 adjusted schedules, and 9 terminated agreements.[10]

Enriched Uranium.—ERDA reported enrichment revenues of $458.5 million in 1975 for separative work furnished under enrichment contracts. A total of nearly 9.8 million separative work units (SWU)[11] was carried out for 24 domestic and 17 foreign customers.

In June ERDA announced plans to maintain the enrichment tails assay at 0.20% U^{235} through September 30, 1977, followed by stepwise increases to 0.30% U^{235} by September 30, 1981. The increases were necessary to support the reactors under development and to provide more feed to permit additional production of enriched uranium for the ERDA reserve stockpile.

The ongoing ERDA Cascade Improvement Program and Cascade Uprating Program were expected to increase the annual SWU capacity of the Government's three enrichment plants from 17.2 million to 27.7 million by 1980 with new equipment and higher power levels. This capacity was expected to be adequate until the mid-1980's. Expansion of the Government diffusion enrichment plant at Portsmouth, Ohio, had been proposed to provide future enrichment capacity. Legislative action on the proposal was expected in 1976.

On June 25, 1975, the President proposed a program to Congress, the Nuclear Fuel Assurance Act, that would end the Government monopoly in uranium enrichment and authorize and encourage the development of uranium enrichment facilities by private industry. The proposal would lead to a competitive uranium enrichment industry in the United States and provide for future enrichment capacity with a minimum of Government funding.[12]

Four private groups have submitted proposals to ERDA for the construction and operation of privately-owned uranium enrichment facilities. CENTAR Associates, a joint venture of ENI Nuclear Co. and ARCO Nuclear Co., wholly-owned subsidiaries of Electro-Nucleonics, Inc., and Atlantic Richfield Co., respectively, planned a 3-million-SWU gas centrifuge plant to be built in stages at a total cost of about $1.1 billion. CENTAR estimated startup in 1981 and full production in 1987 if the legislation passed. Proposals for similar size gas centrifuge plants were also submitted by Exxon Nuclear Co., Inc., and by the Texas Regional Enrichment Corp. (TRENCOR), a subsidiary of Garrett Corp.

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9 Chemical and Engineering News. Beker off Into New Field. V. 53, No. 42, Oct. 20, 1975, p. 8.

10 Thomas, D. C. Future Relationship of Uranium Supply and Enrichment. Energy Research and Development Administration Uranium Industry Seminar Oct. 7–8, 1975, Grand Junction, Colo., pp. 211–227.

11 Measure of work expended in separating a quantity of uranium (in kilograms) at a given assay into two fractions—one enriched in U^{235} to a specific grade and the other deficient in U^{235} to a specific tailings grade.

12 Chemical Week. New Vistas Stir Nuclear Industry. V. 117, No. 3, July 3, 1975, p. 15–16.

Uranium Enrichment Associates (UEA), a joint venture of Bechtel Power Corp., Goodyear Tire & Rubber Co., and Williams Energy Co., submitted plans to build a 9-million-SWU gaseous-diffusion plant near Dothan, Ala. The cost of the UEA project was estimated at $3.75 billion.

Table 8.—Domestic processing and production facilities for uranium nuclear fuels in 1975

Company	Location	Product or service
Allied Chemical Corp	Metropolis, Ill	UF_6.
Allied-General Nuclear Service, Inc.	Barnwell, S.C	Reprocessing;[1] Conversion enriched U to UF_6.[1]
Babcock & Wilcox Co	Apollo, Pa	UO_2; UO_2 pellets; fabrication of UO_2 fuels; depleted U compounds; U scrap; highly enriched U to UF_6.
Do	Leechburg, Pa	Fabrication of carbide, special, U^{233}, and Pu fuels; depleted U metal; Pu scrap.
Do	Lynchburg, Va	UO_2;[1] UO_2 pellets; fabrication of UO_2 and Pu fuels.
Combustion Engineering Inc.	Windsor, Conn	UO_2 pellets; fabrication UO_2 and Pu[1] fuels.
Do	Hematite, Mo	UO_2; UO_2 pellets.
Exxon Nuclear Co., Inc	Richland, Wash	Reprocessing;[2] UO_2; UO_2 pellets; fabrication UO_2 and Pu fuels; U[1] and Pu scrap.[1]
General Atomic Co	San Diego, Calif	Fabrication of carbide and special fuels.
Do	Youngsville, N.C	Fabrication of carbide[1] and special fuels.[1]
General Electric Co	Morris, Ill	Reprocessing; conversion enriched U to UF_6.[2]
Do	San Jose and Vallecitos, Calif.	Fabrication of Pu fuels; U and Pu scrap.
Do	Wilmington, N.C	UO_2; UO_2 pellets; fabrication of UO_2 fuels; U scrap.
Goodyear Atomic Corp.[3]	Portsmouth, Ohio	Enriched UF_6.
Kerr-McGee Corp	Cimarron, Okla	UO_2; UO_2 pellets; fabrication of UO_2, special, and Pu fuels; depleted U metal and compounds; U scrap.
Do	Sequoyah, Okla	UF_6.
NL Industries Inc	Albany, N.Y	Depleted U metal.
North American Rockwell Corp., Atomics International Div.	Canoga Park, Calif	Fabrication of carbide, special, and Pu fuels; depleted U compounds and metal; Pu scrap.[1]
Nuclear Fuel Services, Inc.	Erwin, Tenn	UO_2; UO_2 pellets; fabrication of carbide, U_{233}, and Pu fuels; depleted U metal and compounds; U and Pu scrap.
Do	West Valley, N.Y	Reprocessing;[4] enriched U to UF_6.[1]
Tennessee Nuclear Specialties, Inc.	Jonesboro, Tenn	Depleted U metal and compounds.
Texas Instruments Inc	Attleboro, Mass	Fabrication of special fuels.
Union Carbide Corp.[3]	Oak Ridge, Tenn	Enriched UF_6.
Do[3]	Paducah, Ky	Do.
United Nuclear Corp	Wood River Junction, R.I.	U scrap.
United States Nuclear Corp.	Oak Ridge, Tenn	Fabrication of special fuels.
Westinghouse Electric Corp.	Cheswick, Pa	Fabrication of carbide and Pu fuels; Pu scrap.
Do	Columbia, S.C	UO_2; UO_2 pellets; fabrication of UO_2 fuels; U scrap.[1]
Do	Anderson, S.C	Fabrication of Pu fuels;[1] Pu scrap.[1]
Whittaker Corp., Nuclear Metals Div.	West Concord, Mass	Fabrication of special fuels; depleted U metal.

[1] Under construction or planned.
[2] Status undetermined.
[3] Contractor for Energy Research and Development Administration.
[4] On standby; facilities under modernization and expansion.

Principal source: Energy Research and Development Administration, Office of Industry Relations.

Fuel Fabrication.—Fuel fabrication orders continued to increase in 1975, despite worldwide deferral or rescheduling of major nuclear generating plants by electric utilities. Exxon Nuclear Co., Inc. was again doubling the capacity of its fuel fabrication plant in Richland, Wash.[13] A previous doubling of the plant's capacity was completed in 1974.

NRC proposed halting the issuance of licenses for use of mixed oxide fuels in light-water power reactors until 1978, when it expected to make a final decision on plutonium recycling.[14] NRC was, however, allowing limited reprocessing and use of plutonium in mixed fuels for experimental purposes.

Fuel Reprocessing.—As in 1974, there was no operable commercial spent fuel reprocessing capacity in 1975. The Barnwell, S.C., nuclear fuel plant, with a planned reprocessing capacity of 1,650 tons of uranium per year, was virtually completed during 1975 by Allied-General Nuclear Services, Inc. (AGNS). NRC, however, has not approved operation of the facility pending resolution of problems related to safeguards of plutonium, mixed-oxide fuel usage, and environmental considerations. Although licensing of the reprocessing facility was delayed, it appeared likely that NRC would approve licensing of the Barnwell fuel receiving and storage station whereby AGNS would be authorized to store irradiated nuclear fuel.[15]

Nuclear Fuel Services, Inc. (NFS) was planning to modify its West Valley, N.Y., plant to increase both storage and reprocessing capacity. The NFS plant was not expected to be licensed or operating for several years.

ERDA projections indicated a shortfall in reprocessing capacity through 1985. The situation was expected to worsen with delays in licensing of present capacity and slippages in scheduled future capacities. The major reason given for insufficient planned commercial capacity was uncertainties in Government policy and licensing requirements for plutonium recycling and waste management. Continued delays in fuel reprocessing were expected to cause possible future shortages in spent fuel storage capacity.[16] A study by the Nuclear Assurance Corp. indicated that the operations of some nuclear power units could be affected by a lack of spent fuel storage capacity by 1979. To help alleviate part of the problem, a number of manufacturers have redesigned spent-fuel storage racks to accommodate more assemblies in a typical fuel pool.[17] New designs have increased the storage capacity by factors of from 1.5 to 4 depending on the design in existing facilities and seismic requirements.

Waste Management.—Low-level commercial waste was buried at six sites in Kentucky, Nevada, South Carolina, Illinois, New York, and Washington in 1975. About 2 million cubic feet of waste was added to these sites in 1975, increasing the total buried to about 13 million cubic feet. These sites were estimated to have the capacity to handle low-level wastes until the mid-1990's. ERDA operated large land burial sites at five principal facilities for ERDA-generated waste. These sites contained about 43 million cubic feet of radioactive waste, exclusive of classified waste. About 1.3 million cubic feet were added in 1975. Leakage and migration of radioactive elements from several sites, both commercial and Government, caused environmental problems. Studies were planned by the States involved, ERDA, NRC, U.S. Geological Survey, and the Environment Protection Agency to correct the situation.

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[13] Exxon Corp. 1975 Annual Report. P. 12.

[14] Nuclear News. NRC Wants Delay to 1978 on Mixed-Oxide Decision. V. 18, No. 8, June 1975, p. 51.

[15] Nuclear News. NRC Considers License for Barnwell Storage Plant. V. 18, No. 10, August 1975, p. 50.

[16] Nuclear News. V. 18, No. 11, September 1975, p. 19.

[17] Nuclear News. Reprocessing Halt Brings New Design Fuel Racks. V. 18, No. 8, June 1975, pp. 51–52.

CONSUMPTION AND USES

During 1975, the domestic commercial nuclear power industry was beset by problems of raising capital and public concern for reactor safety. In addition, energy conservation practices resulted in reduced energy forecasts, which added to delays in nuclear powerplant schedules. Numerous reactor deferrals and a few cancellations were announced. All high-temperature, gas-cooled reactors (HTGR) were canceled.[18] Deferrals affected many nuclear power plants under construction or planned. As a result ERDA's short-term (to 1985) demand projections were reduced from earlier forecasts, but the long-term forecast (to 2000) was little affected. The number of plants expected to go into commercial operation by 1985 declined from 190 calculated in June to 182 as of December.

Despite adverse factors, the industry continued to move forward. Three powerplants (2,785 megawatts) became operable; 11 nuclear power generating units (13,350 megawatts) to be located at 7 power stations were planned in 1975.[19] In 1974, 30 units with a total capacity of 36,378 megawatts were planned. Domestic reactor status was as follows, at yearend:

Status	Number of installations	Capacity (megawatts electric)
Operable	[1]58	39,595
Under construction	87	88,138
Planned	93	108,995
Total	238	236,728

[1] Includes two ERDA-owned plants.

This compares with 235 units and 232,720 megawatts at yearend 1974.

Electrical consumption during 1975 increased 2% over that of 1974, according to statistics compiled by the Edison Electric Institute. The increased production of electricity was primarily attributed to rising electrical generation by nuclear powerplants, which provided nearly 9% of all electricity produced in the United States in 1975. According to an Atomic Industrial Forum (AIF) survey, the nuclear contribution reportedly represented fossil fuel savings of more than 10 billion gallons of oil or more than 55 million tons of coal. The AIF survey placed the average cost of a nuclear-generated kilowatt-hour in 1975 at 12.27 mills, 63% less than oil and 30% less than coal.

Table 9.—Current and projected domestic U_3O_8 demand[1]
(Short tons)

Year	Demand	
	Annual	Cumulative
1975	8,100	8,100
1976	10,700	18,800
1977	17,400	36,200
1978	21,100	57,300
1979	25,200	82,500
1980	31,400	113,900
1985	31,700	285,600
1990	31,800	449,500

[1] Feed materials required for enrichment services. Enrichment tails assays (0.20% to Oct. 1, 1978, 0.25% to Oct. 1, 1979, 0.275% to Oct. 1, 1981, and 0.29% thereafter). Uranium recycle 1981 and plutonium recycle 1983.

Source: Energy Research and Development Administration.

Table 10.—Current and projected domestic commercial uranium delivery commitments
(Short tons U_3O_8)

Year	Commitments[1]	
	Annual	Cumulative
1966–74	--	[2]67,500
1975	12,500	80,000
1976	15,900	95,900
1977	13,800	109,700
1978	16,400	126,100
1979	16,500	142,600
1980	15,200	157,800

[1] In the post-1980 period, through 1994, an additional 48,000 tons have been committed. In addition, 11,000 tons have been committed to foreign buyers, of which 7,000 tons were delivered prior to 1975.
[2] Pre-1975 deliveries were 67,500 tons.

Source: Energy Research and Development Administration.

An ERDA survey of uranium producers, utility companies, and reactor manufacturers indicated that uranium supply arrangements for planned U.S. nuclear fuel capacity did not provide adequate coverage of future needs.[20] Procurement efforts in

[18] Nuclear News. Summit Project Cancelled; GA Ponders Next Move. V. 18, No. 15, December 1975, pp. 35–36.
[19] Energy Research and Development Administration. Eleven Nuclear Power Reactors Announced in 1975. News Release No. 76–6, Grand Junction, Colo., Jan. 26, 1976, 4 pp.
[20] Energy Research and Development Administration. Survey of United States Uranium Marketing Activity. ERDA 76–46, Washington, D.C., April 1976, 28 pp.

1975 did not significantly improve the situation, indicating that a substantial contracting effort by uranium producers and utilities was necessary in the next 10 years.

Table 11.—Uranium fuel supply arrangements for domestic nuclear reactors [1]
(Percent of total nuclear generating capacity)

Source of supply	First core	Reloads [2]											
		1	2	3	4	5	6	7	8	9	10	11	12
Primary producers	32	34	27	22	18	15	8	7	5	4	4	2	2
Reactor manufacturers	18	16	13	8	5	4	2	1	0.4	-	-	-	-
Imports	11	3	3	4	4	3	1	1	1	1	1	1	1
Total	61	53	43	34	27	22	11	9	6	5	5	3	3
Total (1974) [3]	61	58	50	44	37	31	23	9	6	5	5	3	3

[1] As of yearend 1975. Includes reactors operating, under construction, and scheduled totaling 207,000 megawatts. Does not include leases from ERDA, which are small, comprising less than 0.2% for first cores and for refueling through sixth reload, when they are scheduled to terminate.
[2] Refueling estimated on annual basis.
[3] Based on 216,000 megawatts.

Source: Energy Research and Development Administration.

In December, NRC issued the first preliminary design approval for a standard nuclear powerplant. Two other applications for standardized design were nearly completed.[21] Standardization was expected to further increase the margin of safety and offer advantages in scheduling, construction, and operation.

Late in 1975, NRC issued a draft generic environmental statement on floating nuclear powerplants (FNPP). The statement covered the environmental considerations of siting and operating FNPP in the coastal waters of the Atlantic Ocean and the Gulf of Mexico and certain river and estuarine locations.[22] As proposed, Offshore Power Systems Inc., a joint venture of Westinghouse Electric Corp. and Tenneco Inc., planned to manufacture on an assembly line basis, eight nuclear powerplants, mounted on floating platforms, at a facility on Blount Island in Jacksonville, Fla. The completed powerplant was to be towed to the site and moored within protective breakwaters. Plans called for the first FNPP to be sited off the coast of New Jersey if approval is given.

Studies were underway on the feasibility of nuclear energy centers, which would include a concentration of nuclear powerplants, nuclear fuels manufacturing and reprocessing, and waste management, all at one site. The nuclear energy center concept was proposed to alleviate some reactor and fuel-cycle problems and provide better safeguards against undesirable diversion of plutonium or enriched uranium. A draft study of NRC indicated that nuclear energy centers containing up to 20 reactors were both feasible and practical.[23]

[21] Nuclear Regulatory Agency. NRC Staff Issue First Preliminary Design Approval of Standardized Nuclear Power Plant. News Release No. 75–290, v. 1, No. 45, week ending Dec. 23, 1975, pp. 4–5.
[22] Nuclear Regulatory Agency. NRC Issues Draft Generic Environmental Statement on Floating Nuclear Power Plant Project. News Release No. 75–285, v. 1, No. 44, week ending Dec. 16, 1975, p. 1.
[23] Nuclear Industry. Nuclear Energy Center Survey. V. 22, No. 12, December 1975, p. 52.

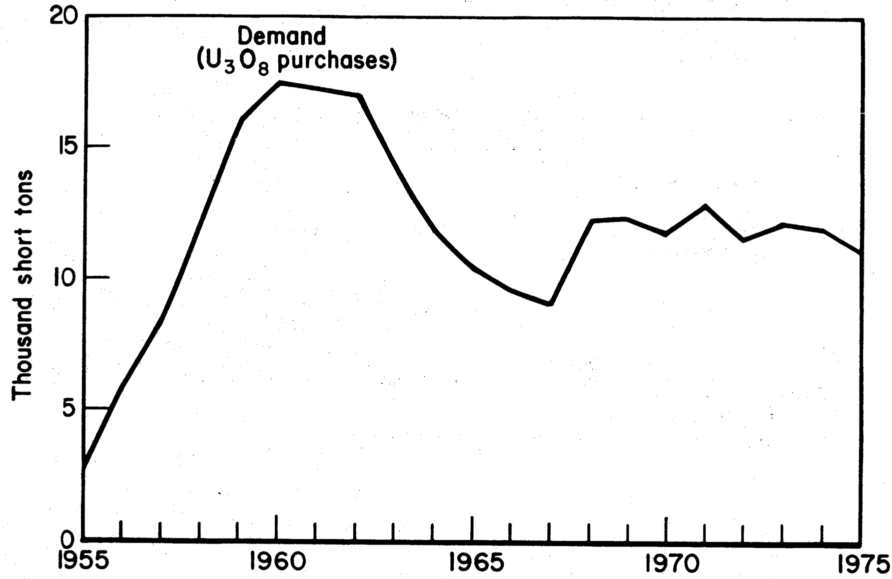

Figure 1.—Domestic uranium demand.

STOCKS

Stocks held by the producers, or milling companies, were reduced during 1975, whereas those held by the consuming industry increased by 2,400 tons of U_3O_8, as indicated in the following data provided by ERDA (in tons of U_3O_8):

	Jan. 1, 1975	Dec. 31, 1975
In ore at mills	300	200
In process at mills	400	400
In concentrate at mills	4,300	2,700
In concentrate held by utility companies, reactor manufacturers, and agents (including equivalent U_3O_8 in UF_6)	20,200	22,600
Total	25,200	25,900

A 1,100-ton inventory of foreign U_3O_8 was also reported.

The stockpile of depleted uranium continued to grow as a result of large-scale enrichment services provided for domestic and foreign customers. The ERDA tailings stockpile contained about 220,000 tons of uranium in the form of UF_6 at the end of 1975.

PRICES

The price for spot sales and future deliveries of U_3O_8 in concentrate continued to escalate during 1975. The strong sellers' market that developed in 1974 continued to be reflected in newly negotiated 1975 contracts, many of which called for prepayments, price adjustments, or payments based on prices prevailing at the time of delivery. The market was further spurred on at the end of 1975 by the announcement by Westinghouse Electric Corp. in September that the company would not be able to meet uranium contract commitments.[24]

[24] Chemical Week. Uranium Pact Disputed. V. 117, No. 12, Sept. 17, 1975, p. 21.

According to the Nuclear Exchange Corp. (Nuexco), the spot bid price increased from $15 per pound of U_3O_8 for delivery in January to $35 at yearend. During this period, the bid price for delivery in 1980 increased from $25.35 to $47.45 per pound.[25]

An ERDA survey indicated significantly lower U_3O_8 prices paid by reactor manufacturers and utility companies having long-term contracts.[26] According to the survey, contract prices representing 84% of commitments ranged from $6.50 to $30 per pound of U_3O_8, averaging $10.50. In 1974 the average price per pound of U_3O_8 was $7.65. An average price of $14.35 per pound of U_3O_8 was indicated by the survey for 1980.

Uranium ore was purchased by General Electric Co. at its Naturita, Colo., ore buying station for 95% of one-half the listed spot price per pound of contained U_3O_8. A minimum of 2 pounds of U_3O_8 per ton of ore was required for purchase.

The costs for enrichment services continued to rise because of increasing actual and projected costs, primarily for electric power. In fiscal 1975, the cost of electric power added about $8 per SWU to enrichment charges. Increases in operating capital and process development costs added an additional $2 per SWU. Effective August 20, 1975, ERDA increased the price per SWU for fixed-commitment contracts to $53.35 from $42.10. For requirement-type contracts, the cost was increased in December from $47.80 to $60.95 per SWU or the ceiling charge, whichever was less.

In June, ERDA forwarded to Congress draft legislation that would revise the basis for establishing prices of uranium enriching services.[27] The legislation was proposed to allow ERDA to obtain fair value for enrichment services, now based on cost recovery pricing, and to reduce the differential between Government charges and those of potential domestic private enrichment projects.

Depleted uranium metal in 300-pound ingots (Derby metal) was priced at $2 per pound.

FOREIGN TRADE

Uranium was imported in the form of U_3O_8 for conversion to UF_6 and enrichment, and as UF_6 for enrichment. Exports of the enriched uranium products are included in special nuclear materials, the quantity of which is not available. Imports of U_3O_8 concentrate were lower in 1975, but imports of other compounds, largely UF_6, were higher.

In 1975 an additional 4,400 tons of foreign uranium was contracted for, bringing the total foreign procurement to 45,400 tons. Commitments by domestic uranium producers to foreign buyers increased by 400 tons of U_3O_8 during 1975, raising the total commitment to 4,000 tons. ERDA reported that 500 tons of U_3O_8 was delivered to foreign buyers in 1975.

Restrictions on the enrichment of foreign uranium for domestic use were to continue until 1977, at which time up to 10% of a utility's uranium requirements could come from foreign sources. The allowable percentage was to be increased each year until 1984 when 100% of a utility's uranium requirements could come from imported material.

[25] Nuclear Exchange Corp. Nuexco Monthly Report to the Nuclear Industry. No. 89, Dec. 31, 1975, p. 3.

[26] Page 6 of work cited in footnote 20.

[27] Energy Research and Development Administration. ERDA Proposes Legislation To Revise Basis for Establishing Price of Uranium Enriching Services. News Release No. 16, Grand Junction, Colo., June 27, 1975, 2 pp.

Table 12.—Foreign trade in uranium, uranium-bearing materials, and other nuclear materials, by principal country

Product	1974 Quantity	1974 Value	1975 Quantity	1975 Value	Principal sources and destinations, 1975
EXPORTS					
Uranium:					
Ores and concentrates, U_3O_8 content --- pounds --	--	--	122,663	$1,839,953	United Kingdom 88,490; West Germany 34,173.
Compounds - do ----	4,682,926	$30,855,227	3,837,266	52,039,852	Canada 1,845,212; West Germany 701,851; United Kingdom 676,872; France 444,941; Netherlands 158,714.
Metal including alloys [1] --- do ----	20,496	321,982	14,840	203,415	Japan 8,496; Italy 2,732; Australia 1,762; Canada 1,155.
Isotopes (stable) and their compounds ------	NA	2,786,077	NA	2,679,033	Netherlands $466,494; West Germany $395,181; France $389,929; United Kingdom $315,251; Canada $219,415; Brazil $158,252; East Germany $149,042; Japan $142,063.
Radioactive materials:					
Radioisotopes, elements, and compounds [2] thousand curies --	25,431,262	16,571,478	37,850,386	20,087,647	West Germany 12,029,513; Canada 7,291,451; Ecuador 4,526,520; Colombia 1,529,630; Switzerland 1,329,798; Australia 799,040; Mexico 972,811; Brazil 629,601.
Special nuclear materials [3] ------------	NA	158,266,718	NA	236,848,895	West Germany $88,756,146; Japan $52,441,761; France $32,920,042; Italy $15,966,959; Belgium-Luxembourg $11,917,525; Switzerland $8,187,437; Austria $6,882,413; United Kingdom $5,408,223; India $5,009,640; Sweden $3,089,191; Canada $3,577,602; Spain $1,879,728.
IMPORTS					
Uranium:					
Oxide (U_3O_8) pounds --	3,670,678	30,284,189	2,451,538	24,480,662	Canada 2,280,065; France 142,632; United Kingdom 28,841.
Other compounds do ----	12,866,822	90,921,175	19,226,578	161,507,129	France 7,414,725; Canada 7,075,964; United Kingdom 4,735,889.
Isotopes (stable) and their compounds ------	NA	1,007,342	NA	957,175	Canada $417,465; U.S.S.R. $214,651; West Germany $94,854; Japan $85,159; United Kingdom $54,774.

See footnotes at end of table.

Table 12.—Foreign trade in uranium, uranium-bearing materials, and other nuclear materials, by principal country—Continued

Product	1974		1975		Principal sources and destinations, 1975
	Quantity	Value	Quantity	Value	
IMPORTS—Continued					
Radioactive materials:					
Radioisotopes, elements, and compounds[4] thousand curies	24,246,498	$7,564,834	35,346,036	$8,296,907	Canada 15,786,244; United Kingdom 9,543,065; France 6,951,527; Switzerland 1,920,846; Belgium-Luxembourg 595,294; Sweden 391,206.

NA Not available.
[1] Includes thorium.
[2] Includes carbon-14 and cobalt-60.
[3] Includes plutonium, uranium-233, uranium-235, and enriched uranium.
[4] Includes cobalt-60.

Table 13.—U.S. uranium import and export commitments
(Short tons U_3O_8)

Year	Exports		Imports	
	Annual	Cumulative	Annual	Cumulative
1975	500	500	1,100	1,100
1976	1,000	1,500	2,800	3,900
1977	1,400	2,900	2,500	6,400
1978	800	3,700	3,300	9,700
1979	300	4,000	3,200	12,900
1980	--	4,000	4,100	17,000
1981–1985	--	4,000	19,100	36,100
1986–1990	--	4,000	9,300	45,400

Source: Energy Research and Development Administration.

WORLD REVIEW

Nuclear power growth continued to expand, though at a more modest rate than was predicted before the 1973 oil crisis. In 1975, developed countries that had little or no energy alternatives generally continued extensive programs for the development of nuclear power, whereas those countries with coal or oil resources, tended to reduce nuclear energy projections. France, for example, maintained its nuclear program adoped in 1973 whereas the United Kingdom substantially reduced its nuclear program, directing greater attention to domestic coal and North Sea oil. Some of the developing nations also continued to formulate nuclear programs or place greater emphasis on nuclear power as a means of increasing energy supplies; however, increasing cost and capital shortages were delaying most programs.

Energy conservation practices and the downturn in world economic growth hindered growth in the industry in 1975 and influenced planning for future primary and enriched uranium supplies. Public attitudes concerning the environment, reactor safety, and plutonium and waste management were further constraints on nuclear development. The threat of nuclear weapons proliferation through diversion of nuclear fuels, facilities, and materials increasingly caused concern internationally and in 1975, affected U.S. reactor sales to countries that had not signed the Non-Proliferation Treaty.

Table 14.—Estimates of nuclear power growth in Europe [1]
(Thousand megawatts installed)

Country	1976	1980	1985	1990	2000
France	5.0	20.4	56.0	90.0	170
West Germany	7.0	19.1	44.6	77.0	134
Italy	1.4	1.4	26.4	62.0	140
Spain	1.1	8.7	23.7	42.0	80
Sweden	3.2	7.4	11.3	16.3	24
Switzerland	1.0	3.8	8.0	8.0	12
United Kingdom	7.2	11.1	15.4	31.0	115
Other [2]	2.2	6.2	26.2	51.5	123
Total (for OECD Europe)	28.1	78.1	211.6	377.8	798

[1] October 1975 estimate.
[2] Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Turkey.

Source: Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency.

The demand for electricity continued to grow at a low rate, with nuclear power the fastest growing electrical energy form. Worldwide, operable nuclear capacity increased from 67,943 megawatts in 1974 to 75,103 megawatts in 1975.

According to data compiled by the American Nuclear Society, 104 plants outside the United States were operable in 18 countries and 168 nuclear units were planned in 29 countries at yearend. This compares with 98 plants operable in 18 countries and 149 units planned in 27 countries at the end of 1974. Most of the planned units were scheduled for completion by 1985.

Table 15.—Operable foreign nuclear powerplants in 1975

Country	Number of units	Capacity (megawatts electric)
Argentina	1	319
Belgium	3	1,650
Bulgaria	2	880
Canada	6	2,512
Czechoslovakia	1	110
France	10	2,818
Germany, East	3	950
Germany, West	7	3,293
India	3	602
Italy	4	1,387
Japan	11	5,877
Netherlands	2	532
Pakistan	1	125
Spain	3	1,073
Sweden	4	2,409
Switzerland	3	1,006
U.S.S.R	12	4,635
United Kingdom	28	5,330
Total	104	35,508

Source: American Nuclear Society.

Table 16.—Scheduled foreign nuclear powerplants [1]

Country	Number of units	Capacity (megawatts electric)
Argentina	1	600
Austria	1	692
Belgium	4	3,797
Brazil	3	3,226
Bulgaria	2	880
Canada	14	9,324
Czechoslovakia	4	1,760
Finland	4	2,160
France	20	18,478
Germany, East	4	1,760
Germany, West	19	19,969
Hungary	4	1,760
India	5	1,082
Iran	4	4,200
Italy	5	3,908
Japan	13	9,628
Korea, Republic of	3	1,798
Luxembourg	1	1,300
Mexico	2	1,320
Philippines	2	1,252
Poland	1	440
Romania	1	440
Spain	8	7,242
Sweden	7	5,940
Switzerland	5	4,847
Taiwan	6	4,924
U.S.S.R	13	9,730
United Kingdom	11	6,450
Yugoslavia	1	615
Total	168	129,522

[1] Under construction or ordered, as of Dec. 31, 1975.

Source: American Nuclear Society.

Western Europe and Japan continued to rely on enrichment services from the United States but the Europeans planned to become self-sufficient in enrichment in the mid-1980's. Urenco Ltd., a tripartite organization of the Netherlands, the United Kingdom, and West Germany, was constructing commercial gas centrifuge enrichment plants at Almelo, Netherlands, and at Capenhurst, United Kingdom. Urenco planned to have the first sections of both production plants, having capacities of 200,000 SWU, completed by early 1977. Plans called for Urenco capacity to reach 2 million SWU per year by 1982 and 10 million SWU per year by 1985. The company reportedly had $1.5 billion in orders for 25 million SWU for delivery between 1977 and 2000.[28] Eurodif, a five-nation consortium comprising France, Belgium, Iran, Italy, and Spain, continued construction of a 10-million-SWU gaseous diffusion enrichment plant at Tricastin, France. The plant was scheduled for completion in 1980. Another group, Coredif, a joint venture of Eurodif and Iran, was planning to construct a similar-sized, diffusion enrichment facility, also at Tricastin, to meet projected shortfalls in enrichment capacity in the mid-1980's. The first stage, 5 million SWU capacity, was expected to be onstream in 1985 with full production in 1988.

Others around the world were also building or planning to build enrichment pilot plants. Japan's Power Reactor and Nuclear Fuel Development Corp. (PRF) was proceeding with the construction and operation of a 50,000-SWU-capacity, pilot centrifuge enrichment plant. PRF proposed building a 500,000-SWU demonstration plant by 1984 followed by a 1-million-SWU capacity commercial plant by 1988, with capacity increasing to 4 million SWU by 1995. The Uranium Enrichment Corp. of South Africa Ltd. (UCOR) completed construction of its pilot plant at Valindaba to test a "helikon" cascade design used in conjunction with a modified jet nozzle enrichment technique. A decision to construct a commercial scale plant, estimated at a 5-million-SWU-per-year capacity, was expected in 1978. Brazil and West Germany planned to build a 180,000-SWU-per-year demonstration enrichment plant in Brazil using an advanced nozzle enrichment method. A large-scale commercial plant with a capacity of 1 to 2 million SWU per year was to follow viability studies.

Progress continued toward solving problems in the backend of the fuel cycle. Research programs dealing with spent fuel storage, reprocessing, and waste management continued in those countries having large nuclear programs.

[28] Nuclear News. Urenco Has $1.5 Billion in Orders So Far. V. 18, No. 11, September 1975, p. 59.

Table 17.—Uranium oxide (U_3O_8) concentrate: World production by country
(Short tons)

Country [1]	1973	1974	1975 p
Argentina	r 51	43	43
Canada [2]	4,759	4,795	6,126
France	1,979	2,130	2,228
Gabon	r 845	1,001	1,209
Niger	r 1,233	1,430	1,820
Portugal e	r 100	r 100	110
South Africa, Republic of	3,411	3,389	3,097
Spain	r 104	80	e 130
Sweden e	80	80	80
United States	13,235	11,528	11,600
Total	r 25,797	24,576	26,443

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed, Australia, Brazil, Czechoslovakia, Finland, East Germany, West Germany, Hungary, India, Israel, Japan, the People's Republic of China, and the U.S.S.R. are believed to have produced uranium oxide, but information is inadequate to make reliable estimates of output levels.
[2] Data represent shipments. Official production for 1975 was reported at 4,631 short tons.

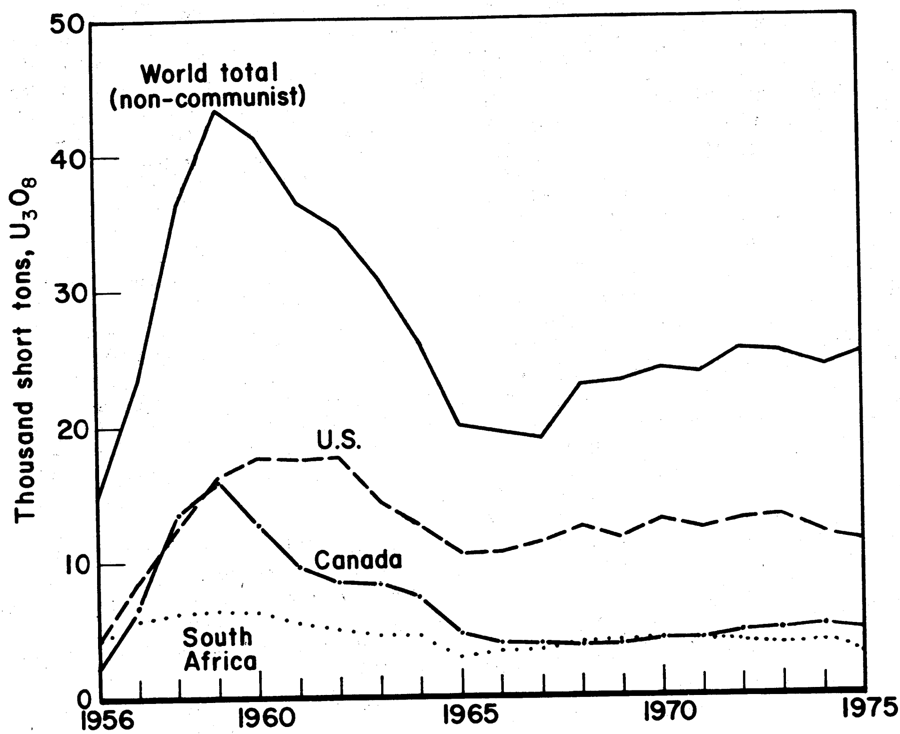

Figure 2.—World production of uranium concentrate (U_3O_8).

Australia.—As of June 30, 1975, Australia's reasonably assured uranium reserves recoverable at less than $10 per pound of U_3O_8 totaled 202,000 tons.[29] This was an increase of about 60,000 tons of U_3O_8 over that estimated in June 1974. Known uranium reserves recoverable at less than $30 per pound of U_3O_8 were estimated at 333,000 tons.[30] The reserves of the various deposits were as follows:

Location	Deposit	Reserves (tons of U_3O_8)
Northern Territory	Ranger	111,000
Do	Nabarlek	10,000
Do	Koongarra	20,000
Do	Jabiluka	115,000
Queensland	Mary Kathleen	10,000
South Australia	Lake Frome	17,000
Western Australia	Yeelirree	50,000
Total		333,000

During much of 1975, the Government's uranium policy continued to delay development of the country's uranium deposits. This policy specified Government ownership of deposits and Government-industry partnerships in the Northern Territory; permitted only the Government, through the Australian Atomic Energy Commission

[29] Australian Atomic Energy Commission. Twenty-third Annual Report. Year ending June 30, 1975.
[30] Western Mining Corp. Ltd. The Australian Uranium Mining Industry. September 1975, 22 pp.

(AAEC), to undertake uranium exploration in certain areas; and allowed no new contracts for uranium sales or new foreign participation. A new Government elected in December was expected to extensively modify this program in 1976. The new Government indicated that it intended to phase the AAEC out of exploration and to allow companies to be relatively free to develop deposits and to negotiate sales contracts. The Government, however, planned to continue to be involved in the industry and indicated that a minimum of 75% Australian ownership in deposits was expected.

Mary Kathleen Uranium Ltd. (MKU) was recommissioning its mine and mill near Mount Isa at a cost of $26 million, preparing for commercial operation in mid-1976.[31] MKU planned production at a rate of 1,000 tons of U_3O_8 per year to fulfill export contract obligations of 5,000 tons of U_3O_8 by 1982. The Mary Kathleen mine was expected to be Australia's only uranium producer for the next 3 to 5 years.

The status of 6,530 tons of U_3O_8 contracted for export by other Australian companies for the period 1977 through 1986 awaited further legislative action; however, the Government planned to honor these contracts from stocks, if necessary.

Brazil.—The Brazilian Government planned to spend more than $500 million on its nuclear program between 1975 and 1979, and a total of $10 billion by 1990 to reduce the country's dependence on energy imports. In June, Brazil signed a 15-year, $4.5 billion agreement with West Germany that will provide uranium reactor and fuel technology. Under terms of the agreement, Brazil will buy eight 1,300-megawatt nuclear powerplants. Several joint German-Brazilian companies were to be established for fuel manufacture and reprocessing, enrichment, and exploration and mining.[32]

The Brazilian state agency Comissão Nacional de Energia Nuclear (CNEN) spent about $17 million in 1975 on uranium prospecting and planned to spend about $20 million in 1976. Measured reserves were about 10,000 tons of U_3O_8 at yearend 1975.

Canada.—Uranium production, about 4,600 tons of U_3O_8 in 1975, was slightly lower than that in 1974 due mainly to shortages of mine labor and the processing of lower grade ores.[33] Exploration activity, however, continued to increase, and significant mineralization was found in several areas, most notably at Key Lake in Saskatchewan. All uranium producers were in the process of expanding facilities. Several new and rehabilitated mines were expected to come onstream in the near future.

According to revised estimates of the Canadian Department of Energy, Mines, and Resources, recoverable uranium reserves to $40 per pound of U_3O_8 totaled 562,000 tons, an increase of 7.8% over those of 1974.[34] A comparison between the 1975 and 1974 (in parentheses) uranium reserve assessment in thousand tons, follows:

Minable, price per pound [1]	Measured	Indicated	Inferred
0–$20	82	107	226
	(77)	(107)	(237)
$20–$40	14	22	111
	(4)	(17)	(84)
Total	96	129	337
	(81)	(124)	(321)

[1] Figures in parentheses are from the 1974 assessment using price categories of up to $15 per pound of U_3O_8 and $15 to $30 per pound of U_3O_8.

In addition to the aforementioned uranium reserve assessment, 450,000 tons of U_3O_8 was estimated to be in potential resources.

Canada's national uranium policy enacted late in 1974 requires at least a 30-year reserve of nuclear fuel for existing, committed, and planned reactors in any 10-year forward period. Allocations, amounting to 21% of each producer's reserves, were applied to provide for the 30-year fueling requirements of 81,000 tons of U_3O_8 for the 14,700 megawatts nuclear capacity expected to be operating in Canada by 1986. The uranium producers had export commitments of about 110,000 tons of U_3O_8 and domestic commitments of 33,000 tons of U_3O_8 at the end of 1975. Production was expected to increase significantly in the next 10 years to meet

[31] Skillings' Mining Review. Mary Kathleen Reopening Uranium Mine. V. 64, No. 37, Sept. 13, 1975, p. 10.

[32] Chemical Week. Uranium for Know-How. V. 117, No. 2, July 9, 1975, p. 22.

[33] Williams, R. M. Uranium. Can. Min. J., v. 97, No. 2, February 1976, pp. 146–149.

[34] Energy, Mines, and Resources Canada. 1975 Assessment of Canada's Uranium Supply and Demand. June 1976, 14 pp.

contract commitments and anticipated demand for uranium. Government estimates of Canadian uranium production to 1985 were as follows:

Year	Tons of U_3O_8
1976	7,600
1977	8,800
1978	10,400
1979	11,600
1980	13,000
1981	13,400
1982	14,400
1983	13,500
1984	15,000
1985	15,000

In 1975, four producers, Denison Mines Ltd., Rio Algom Ltd., Eldorado Nuclear Ltd. (ENL), and Gulf Minerals Canada Ltd. (GMC), produced a total of 4,631 tons of U_3O_8. Shipments were higher, totaling 6,136 tons of U_3O_8. Denison had nearly completed expansion of its mill capacity to 7,100 tons of ore per day by yearend 1975.[35] Rio Algom began a $76 million mine-mill expansion in April.[36] The capacity of the Quirke mill was to be increased from 4,500 tons of ore daily to 7,000 tons by 1978. Three new mine levels were being developed, and shafts at the Milliken and Lacnor mines were being enlarged to increase hoisting capacity.

ENL continued a $15 million program to expand its production rate to 1,000 tons per year of U_3O_8 by 1979. The company was expanding its mill, planning to develop several small open pits, increasing production of the Fay mine, and reopening the Verna mine that closed in 1969.[37] By yearend 1975, the Rabbit Lake open pit operation of GMC, in partnership with Uranerz Canada Ltd., was producing ore. The mill, which has a rated production capacity of 2,000 tons of ore per day or 2,250 tons of U_3O_8 per year, was expected to be fully operational in 1976.

Madawaska Mines Ltd., a joint venture of Federal Resources Ltd. (51%) and Consolidated Canadian Faraday Ltd. (49%), was reopening the Faraday mine and mill, and expected to begin ore production at a rate of 1,500 tons daily by July 1976.[38] Amok Ltd., owned entirely by French interests (Compagnie de Mokta, Cie. Française des Minerais d'Uranium, Péchiney Ugine Kuhlmann, and Commissariat à l'Energie Atomique), planned to bring its Cluff Lake deposit in northern Saskatchewan into production in 1977. An initial milling rate of 200 tons per day was scheduled, followed by a second phase mill with a milling rate of 1,000 to 2,000 tons per day by the late 1980's. Agnew Lake Mines Ltd. continued a $3 million program, begun in 1974, to test large-scale leaching of uranium from broken ore both on surface and underground. The mine, near Espanola, Ontario, was dewatered, and underground development was in progress.

Central African Republic.—In June, the Government, with the Commissariat à l'Energie Atomique (CEA) and Swiss Aluminium Ltd., established Société d'Uranium Centrafricain (URCA) to exploit the uranium deposits at Bakouma.[39] These deposits reportedly contain about 25,000 tons of U_3O_8. Design and construction of a mill was planned after pilot plant testing of the ore in France.

France.—The Government discontinued plans to develop boiling water reactors (BWR), and indicated that all future additions will be pressure water reactors (PWR) of Westinghouse design. In a move to reduce Westinghouse Electric Corp.'s (WEC) share of the French nuclear reactor industry, CEA arranged to obtain 67% of WEC's 45% share of Société Franco-Americain de Conservation Atomiques (Framatome). In 1982, Creusot-Loire, 51% owner of Framatome, was to receive WEC's remaining 15% of the company.

France's prototype fast breeder, the 250-megawatt Phénix, continued to operate successfully at very high load factors. Nucleaire Europeene à Neutrons Rapides S.A., a multinational utility created jointly by France (51%), Italy (33%), and West Germany (16%), planned to order in 1976 a commercial-sized 1,200-megawatt, Super-Phénix. The proposed site for the

[35] Northern Miner. Denison Mill Expansion Virtually Complete. V. 61, No. 34, Nov. 6, 1975, pp. 1 and 16.

[36] Canadian Mining Journal. Rio Algom Gets Into Gear With $76 Million Expansion. V. 96, No. 11, September 1975, pp. 43–50.

[37] Canadian Mining Journal. Eldorado Nuclear Stepping Up Development To Increase Production. V. 96, No. 11, November 1975, pp. 68–73.

[38] Northern Miner. Madawaska Prepares for July Startup. V. 61, No. 33, Oct. 30, 1975, pp. 1 and 11.

[39] U.S. Embassy, Bangui, Central African Republic. State Department Airgram A-008, Mar. 1, 1976, pp. 2–3.

Super-Phénix was at Creys-Malville, France.

India.—In September, the Uranium Corp. of India, Ltd. (UCI), began recovering uranium from copper tailings from the India Copper Corp. mine at Surda.[40] About 400 tons of copper tailings per day was processed in the plant using 20 wet concentrating tables. The lean uranium values in the feed assaying about 0.015% U_3O_8 were upgraded to about 0.12% U_3O_8 at a recovery of 50%. The wet mineral concentrates were transported to UCI's mill at Jaduguda for further processing.

Italy.—AGIP Mineraria purchased a uranium deposit near Novazza and planned to develop the deposit after further exploration.[41] The deposit reportedly contains 1.65 million tons of ore containing 1,650 tons of U_3O_8.

Niger.—In 1975, Niger ranked fifth in the world in both uranium production and in known reserves of uranium ore at $10 per pound of U_3O_8. Production was 1,820 tons of U_3O_8 in 1975 compared with 1,430 tons in 1974. The Arlit mine of Société des Mines de L'Air (SOMAIR), an international consortium composed of Nigerien, French, Italian, and West German interests, was the only uranium producer in 1975. One new mine was under development at Akouta, 5 miles southwest of Arlit, and another at Imouraren, about 50 miles south of Arlit, was being evaluated for possible development. The Government projected that uranium production would increase to 3,300 tons of U_3O_8 by 1978, 4,700 tons of U_3O_8 by 1980, and about 9,500 tons of U_3O_8 by 1985.

In 1975, SOMAIR increased the annual capacity of the Arlit mill to 1,800 tons of U_3O_8 at a cost of about $20 million and scheduled an additional capacity increase of 200 tons of U_3O_8 for completion in 1977.

In June, Compagnie Minière D'Akouta (COMINAK), a consortium composed of Nigerien, French, Spanish, and Japanese companies, began underground development of its Akouta mine. COMINAK planned to achieve a production rate of about 2,000 tons of U_3O_8 per year, beginning in 1978. Reserves, which average about 0.45% U_3O_8 were sufficient for at least 15 years at the scheduled rate of production.

South Africa, Republic of.—Uranium output, as a byproduct and coproduct at seven gold mines, was 292 tons of U_3O_8 lower than that of 1974, owing to the processing of lower grade gold tailings. The uranium content in ore processed decreased from 0.454 pounds of U_3O_8 per ton in 1974, to 0.417 pounds per ton in 1975. Production in 1975, by mine, was as follows:

Mine	Pounds of U_3O_8
Blyvooruitzicht	333,493
Buffelfontein	1,316,820
Harmony	933,500
Hartebeestfontein	913,308
Vaal Reefs	2,051,423
West Driefontein	331,888
Western Deep Levels	313,426
Total	6,193,858

Thirteen gold mines were considered capable of supporting uranium production, and 11 mines had uranium extraction plants. Several uranium mills were being rehabilitated to process uranium-rich gold tailings which continued to be stockpiled.

South-West Africa, Territory of.—Open pit development and mill construction continued on schedule at the Rossing deposit. The initial production rate, 60,000 tons of ore per day and 15 million pounds of U_3O_8 per year, will make the mine the world's largest uranium producer. Future plans called for the ore production rate to be increased to 120,000 tons per day. Initial production was scheduled for late 1976.

Spain.—The Government's Empress Nacional del Uranio, S.A. (ENUSA), scheduled an extensive program to increase production of uranium in the next few years to help meet the country's requirements for nuclear fuel. A 140-ton-per-year uranium mill at Ciudad Rodrigo, Salamanca, was commissioned in 1975, raising Spain's annual production capacity to 220 tons of U_3O_8. By 1978, a new conventional acid leaching-solvent extraction mill, having an annual capacity of 600 tons per year of U_3O_8, was also planned at Ciudad Rodrigo. ENUSA was also scheduled to build a facility in southern Spain to recover about 140 tons of U_3O_8 per year from phosphoric acid production.

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[40] Nuclear India. Recovering Uranium From Copper Tailings. V. 14, No. 6, February 1976, p. 2.

[41] U.S. Embassy, Rome, Italy. Italian Energy Finds. State Department Airgram A-214, May 12, 1975, 2 pp.

Yugoslavia.—Development continued on a uranium deposit near Zirovski Vrh, Slovenia. Reserves were considered adequate to support production of 300 tons of U_3O_8 per year for a period of 15 years. Production was expected by 1978.

TECHNOLOGY

ERDA-sponsored projects to aid uranium exploration and assessment continued. In August, a systematic reconnaissance survey of the country's surface waters, groundwaters, and stream sediments was begun for the purpose of determining the role of uranium and its pathfinders as guides for uranium search.[42] The systematic sampling of the nation's streams was expected to provide evidence of uranium occurrences not previously known. Detection capabilities of LANDSAT multispectral scanner data for use in the search for roll-type uranium deposits were studied.[43] It was found that an image based on a single-ratio technique was adequate to separate hematite haloes near uranium deposits.

Measurement of radioactive bismuth (bismuth-214) in the atmosphere was investigated to improve data obtained during airborne gamma-ray surveys.[44] A low-cost system to explore for uranium deposits under bodies of water was developed in Canada.[45] The survey determines lake bottom topography, delineates outcrop areas, and outlines radiometric anomalies.

Other methods to explore for uranium included: Determination of radium in soil samples,[46] measurement of the relative heat flux between sample points in shallow boreholes,[47] and measurement of delayed fission neutrons in formations.[48] Sandia Laboratories, supported by ERDA, was conducting a feasibility study to determine uranium content in rocks intersected in drillholes. The system employs a pulsed neutron generator which provides neutrons which collide with and split the nuclei of uranium atoms. Neutrons resulting from fissioning are counted to indicate the uranium content.

A comparative study of the geostatistical ore reserve estimation method versus conventional methods using real data from an operating mine illustrated the practicality of the geostatistical method in certain types of uranium ore reserve estimation.[49] The Bureau of Mines studied the Chattanooga Shale to determine the quantity and quality of the uranium resources present and to assess specific environmental effects of mining the shale.[50] The study concluded that the uranium resources are large and could be extracted by known mining and processing technology; however, production, under present conditions, would not be economic and the environmental impact in the production area would be extensive.

Increasing demand and high uranium prices continued to stimulate the industry's interest in in situ leaching or solution mining as a means to reduce investment and construction lead time and to produce from low-grade ore bodies.[51] Methods of petroleum recovery technology were being applied to determine the amenability of uranium-bearing deposits to solution mining. The action of a biological agent such as Thiobacillus or Ferrobacillus in situ reportedly increases the concentration

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[42] Energy Research and Development Administration. ERDA Announces Plans for Nationwide Hydrogeochemical and Stream Sediment Program. News Release No. 29, Grand Junction, Colo., Aug. 8, 1975, 3 pp.

[43] Salmon, B. C., and W. P. Pillars. Multispectral Processing of ERTS-A (LANDSAT) Data for Uranium in the Wind River Basin, Wyoming. Infrared and Optics Div., Environmental Research Institute of Michigan, Ann Arbor, Mich., August 1975, 129 pp.

[44] Energy Research and Development Administration. The Development of an Atmospheric ^{214}Bi Measuring Instrument. GJO-1656, Grand Junction, Colo., December 1975, 19 pp.

[45] Northern Miner. Underwater Radiometry Proving Useful Tool to Locate Uranium. V. 60, No. 51, Mar. 6, 1975, p. 53.

[46] Canadian Mining and Metallurgical Bulletin. A Soil Radium Method for Uranium Prospecting. V. 68, No. 757, May 1975, pp. 51–56.

[47] Hardison, J. E. (assigned to Atlantic Richfield Co.) Exploration for Uranium Ore Bodies. U.S. Pat. 3,874,232, Apr. 1, 1975, 6 pp.

[48] Givens, W. W. (assigned to Mobil Oil Corp.). Method of Determining the Uranium Content of a Formation Traversed by a Borehole. Canadian Pat. 980,017, Dec. 31, 1975, 33 pp.

[49] Energy Research and Development Administration. ERDA Issues Report on Comparative Study of Ore Reserve Estimation Methods. News Release No. 39, Grand Junction, Colo., Sept. 29, 1975, 2 pp.

[50] Mutschler, P. H., J. J. Hill, and B. B. Williams. Uranium From the Chattanooga Shale. Some Problems Involved in Development. BuMines IC 8700, 1976, 85 pp.

[51] Chemical Week. New Solution Cuts Uranium Mining Costs. V. 117, No. 26, Dec. 24, 1975, pp. 28–29.

of weak sulfuric acid leach solution, thereby improving the uranium recovery.[52]

The Bureau of Mines expanded its research and development work on processing technology for recovery of uranium from low grade and refractory ores. Acid-leach extraction of uranium from refractory carboniferous ores, normally resistant to conventional acid leaching, was successful after the ores were subjected to autoclave oxidation or to roasting. Uranium recoveries of up to 93% were reported.

The United Kingdom Atomic Energy Authority developed a new method, known as the ferric leach bacterial regeneration system, to leach uranium from relatively coarse mill-grade ore using acidic ferric sulfate. The bacteria, thiobacillus ferrooxidans, was introduced to convert the leach reaction product ferrous sulfate back to ferric sulfate, which is recycled.

Two process developments resulting in reducing costs 20% to 30% by eliminating steps in the production of UF_6 were described in 1975.[53] A Japanese process developed by Power Reactor and Nuclear Development Corp. and Asahi Chemical Industry Corp., purifies uranium in conventional sulfuric acid leach solution by solvent extraction, followed by stripping with chloride solution. The uranium is put in the uranous state by electrolytic reduction in a cation exchange membrane cell, then precipitated with HF as insoluble UF_4 "green cake." A French process is similar, although in one approach, the uranium in the chloride stage can be chemically reduced with SO_2 in the presence of copper and HF to form "green cake." Both processes produce, in an ore processing plant, a product suitable for direct fluorination to UF_6.

Progress was reported in isotopic enrichment of U^{235} by laser beam in the laboratory. Tests indicated higher separation factors than from other enrichment methods, suggesting that laser methods, if commercially successful, would reduce enrichment plant investment and operating costs.[54] Laser enrichment techniques were based on the selective excitation of U^{235} by tunable lasers followed by chemical separation or by electrical or mechanical separation. Four fundamental requirements were necessary to achieve enrichment: An absorption spectrum in which different isotopes absorb radiation at different wavelengths; a laser that can deliver a very narrow band of radiation so that only one isotope will absorb it; a chemical or physical process that can separate the excited atoms; and atoms that remain excited long enough to achieve separation.[55]

The NRC continued efforts to improve light water reactor (LWR) safety. Research was directed toward developing methods of calculating the course of events if an accident should occur. To assist this effort, NRC conducted tests at the Power Burst Facility (PBF) at the Idaho National Engineering Laboratory to provide data to define the behavior of nuclear fuels under abnormal and hypothetical accident conditions. The Loss-of-Fluid-Test Program (LOFT), NRC's largest experimental facility, was nearing completion and the first experiments were expected in 1976. The LOFT facility was designed to provide verification for analytical methods for prediction of integrated system behavior in a loss-of-coolant accident.

The Ministry of International Trade and Industry (MITI) in Japan planned to conduct a 10-year construction and trials program to test nuclear reactor safety during earthquakes.[56] A $70 million, shaking-table facility, funded by MITI and Japan's nuclear industry, was to be built to test power reactors weighing up to 1,100 tons.

ERDA continued its basic research and development program on four breeder concepts—the liquid metal, fast breeder reactor (LMFBR), the light water breeder, the gas-cooled breeder, and the molten salt breeder. Reference designs, work schedules, and cost data were established for the demonstration Clinch River LMFBR in Tennessee. ERDA planned to have the facility completed in 1983. The Fast Flux Test Facility for testing breeder fuels and materials, and for safety and reactor development experience, was expected to be completed in 1977. Progress was made in

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[52] Sievert, J. A. (assigned to Continental Oil Co.). In Situ Underground Leaching of Uranium From Carnotite or Other Uranium Ore. U.S. Pat. 3,937,520, Feb. 10, 1976, 5 pp.

[53] Chemical Engineering. Uranium Processing Update. V. 82, No. 5, Mar. 3, 1975, pp. 88–89.

[54] Chemical and Engineering News. Lasers Hold Promise for Isotope Enrichment. V. 53, No. 19, May 12, 1975, pp. 17–18.

[55] Chemical Week. New Light on Laser Enrichment. V. 116, No. 22, May 28, 1975, p. 57.

[56] Chemical and Engineering News. J panese Shaker To Test Reactor Safety. V. 53, 43, Oct. 27, 1975, pp. 21–22.

studies on advanced oxide fuels and higher breeding mixed uranium-plutonium carbide and nitride fuels.

The feasibility of a gaseous core nuclear reactor, designed not only to produce power but also to reduce the national inventories of long-lived reactor waste products through nuclear transmutation, was examined.[57] Neutron-induced transmutation of radioactive waste was shown to be an effective means in shortening the apparent half life.

[57] Paternosta, R. R. Nuclear Waste Disposal Utilizing a Gaseous Core Reactor. NASA-CR-146418, Florida Univ., Gainesville, Fla., 1975, 42 pp.

Vanadium

By Grace N. Broderick [1]

Consumption of vanadium in 1975 in the United States showed a decrease of 24% from the alltime high of 1974. This decrease resulted from a decline in steel demand, reduced activity in aircraft construction, and less use of vanadium by the chemical industry. U.S. production of vanadium oxide also was lower in 1975, decreasing by 9%. U.S. price quotations for the principal vanadium materials, which rose appreciably in 1974, remained stable in 1975. Both exports and imports of ferrovanadium were down in 1975. Exports classified as ores, concentrates, oxides, and vanadates increased over those of 1974. Vanadium pentoxide imports, which until 1974 were insignificant, accounted for about one-third of total vanadium imports for consumption in 1975.

Table 1.—Salient vanadium statistics
(Short tons of contained vanadium)

	1971	1972	1973	1974	1975
United States:					
Production:					
Ore and concentrate:					
Recoverable vanadium [1]	5,252	4,887	4,377	4,870	4,743
Value ------ (thousand dollars)	$37,690	$30,867	$26,611	$38,266	$49,329
Vanadium oxides recovered [2]	5,293	5,248	4,864	5,368	4,859
Consumption	4,802	5,227	6,393	7,200	5,501
Exports:					
Ferrovanadium and other vanadium alloying materials (gross weight)	676	269	1,416	1,335	1,018
Vanadium ores, concentrates, oxides, and vanadates	260	176	232	203	215
Imports (general):					
Ferrovanadium (gross weight)	89	578	303	225	179
Ores, slags, residues	2,350	1,400	2,600	r 2,485	2,895
Vanadium pentoxide (anhydride)	30	(3)	(3)	533	1,275
World production	20,502	20,239	r 21,653	r 21,112	23,831

r Revised.
[1] Recoverable vanadium contained in uranium and vanadium ores and concentrates received at mills, plus vanadium recovered from ferrophosphorus derived from domestic phosphate rock.
[2] Produced directly from all domestic sources, and includes metavanadates; in 1971 also includes small byproduct quantities from imported chromium ores.
[3] Less than ½ unit.

Legislation and Government Programs.— As of December 31, 1975, deliveries of previously sold material had reduced the physical inventory of the U.S. Government stockpile to 540 tons of vanadium, all in the form of vanadium pentoxide. This uncommitted excess cannot be sold until Congressional authorization is obtained.

[1] Physical scientist, Division of Ferrous Metals.

DOMESTIC PRODUCTION

Domestic production of vanadium was somewhat lower than that in 1974. The quantity recovered from uranium-vanadium ores of the Colorado Plateau increased in 1975 and exceeded the quantity recovered from Arkansas vanadium ore, which declined from that of the previous year. On a State basis, however, Arkansas retained its position as the principal vanadium producer. The amount of vanadium recovered from ferrophosphorus continued to decline. Some mills also processed fly ash, oil residues, spent catalysts, and foreign vanadium-bearing slags. Vanadium obtained by processing imported vanadium-bearing materials was not included in any of the production figures shown in the tables nor was the vanadium recovered directly from slags or residues as ferrovanadium or similar products.

Union Carbide Corp. continued to operate both its Uravan-Rifle mill complex in Colorado, and its Hot Springs, Ark., mill. The Soda Springs, Idaho, plant of Kerr-McGee Corp. and the Hot Springs, Ark., plant of Union Carbide Corp. produced all the vanadium that was recovered from byproduct ferrophosphorus. By yearend, Atlas Corp. had nearly completed installation of the vanadium recovery circuit at its Moab, Utah, plant.

Producers of vanadium addition agents for use in the production of steel and titanium alloys included Engelhard Minerals & Chemicals Corp.; Foote Mineral Co; Reading Alloys, Inc.; Shieldalloy Corp. (a Division of Metallurg, Inc.); and Union Carbide Corp.

Table 2.—Mine production and recoverable vanadium of domestic origin produced in the United States

(Short tons of contained vanadium)

Year	Mine production [1]	Recoverable vanadium [2]
1971	5,547	5,252
1972	4,699	4,887
1973	4,117	4,377
1974	5,240	4,870
1975	5,213	4,743

[1] Measured by receipts of uranium and vanadium ores and concentrates at mills, vanadium content.

[2] Recoverable vanadium contained in uranium and vanadium ores and concentrates received at mills, plus vanadium recovered from ferrophosphorus derived from domestic phosphate rock.

Table 3.—Production of vanadium oxides in the United States [1]

(Short tons)

Year	Gross weight	Oxide content [2]
1971	10,492	9,448
1972	10,410	9,367
1973	8,226	8,683
1974	9,304	9,583
1975	8,597	8,674

[1] Produced directly from all domestic sources including domestic residues. Includes metavanadates; in 1971, includes small byproduct quantities from imported chromium ores, also.

[2] Expressed as equivalent V_2O_5.

Plans to construct a ferroalloy plant at Pulaski, Pa., to produce ferrovanadium and other alloys were announced by The Pesses Co. The plant, which is expected to be in operation by late 1976, is not expected to produce ferrovanadium until 1977 or 1978, when an arc furnace will be installed.

CONSUMPTION AND USES

Domestic consumption of vanadium by type of material and by end-use category decreased about 24% in 1975 from the alltime high of 7,200 tons set in 1974. Decreases occurred in all end-use categories except carbon steel, cast irons, and welding and alloy hard-facing rods and materials. Eighty-five percent of the vanadium was consumed as ferrovanadium and associated proprietary vanadium-iron-carbon materials. A decline in steel demand, reduced activity in aircraft construction, and less use of vanadium by the chemical industry were responsible for the decreased consumption.

Table 4.—Consumption and consumer stocks of vanadium materials in the United States
(Short tons of contained vanadium)

Type of material	1974		1975	
	Consumption	Ending stocks	Consumption	Ending stocks
Ferrovanadium [1]	6,076	1,732	4,703	868
Oxide	218	83	216	56
Ammonium metavanadate	41	6	26	5
Other [2]	865	163	556	212
Total	7,200	1,984	5,501	1,141

[1] Includes other vanadium-iron-carbon alloys.
[2] Consists principally of vanadium-aluminum alloy, plus relatively small quantities of other vanadium alloys and vanadium metal.

Table 5.—Consumption of vanadium in the United States, by end use
(Short tons of contained vanadium)

End use	1975
Steel:	
Carbon	931
Stainless and heat resisting	20
Full alloy	1,307
High-strength low-alloy	2,004
Electric	W
Tool	413
Cast irons	59
Superalloys	26
Alloys (excluding steels and superalloys):	
Cutting and wear resistant materials	W
Welding and alloy hard-facing rods and materials	12
Nonferrous alloys	425
Other alloys [1]	W
Chemical and ceramic uses:	
Catalysts	239
Other [2]	W
Miscellaneous and unspecified	65
Total	5,501

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."
[1] Includes magnetic alloys.
[2] Includes pigments.

STOCKS

In addition to the consumers' stocks shown in table 4, producers' stocks of vanadium as fused oxide, precipitated oxide, metavanadate, metal, alloys, and chemicals totaled 3,375 tons of contained vanadium at yearend 1975, compared with 1,920 tons at yearend 1974.

PRICES

Prices in the United States for the principal vanadium materials were stable throughout 1975. The price for domestic 98% fused vanadium pentoxide, as quoted by Metals Week, continued as a dual quotation of $2.45 and $3.06 per pound of contained V_2O_5 for the entire year. Prices for technical-grade, air-dried vanadium pentoxide remained at $2.98 and $3.06 per pound of contained V_2O_5 in 1975.

The price for U.S. standard grade ferrovanadium remained at $6.35 per pound of contained vanadium, and the price of Carvan and Ferovan remained at $5.10 per pound of contained vanadium during the year.

FOREIGN TRADE

Exports of ferrovanadium were down about 24% in 1975 but exports of vanadium ores, concentrates, and oxides rose 6% over those of the previous year. The average declared value for exports of ores, concentrates, and technical-grade oxides was $2.12 per pound of contained vanadium pentoxide in 1975, compared with $1.83 per pound in 1974. The average declared value for exports of ferrovanadium in 1975 was $3.91 per pound of alloy, compared with $2.94 in 1974.

Ferrovanadium imports declined in quantity but increased in value. No imports classified as vanadium ore and concentrate were received in 1975. Imports of vanadium-bearing residues, such as ashes and slags, totaled 5.8 million pounds of contained vanadium in 1975, compared with 5.0 million pounds of contained vanadium in 1974. Most of this material continued to come from the Republic of South Africa, the U.S.S.R., and Chile.

Imports for consumption of vanadium pentoxide (anhydride) totaled 4,297,303 pounds valued at $7,873,796, compared with 1,904,182 pounds valued at $2,931,329 in 1974.

Tariffs.—Imports of vanadium pentoxide (anhydride) are presently designated as TSUSA 422.60 in the Tariff Schedules of the United States (Annotated). They are dutiable at 16% ad valorem for favored nations; the statutory rate is 40% ad valorem.

Table 6.—U.S. exports of vanadium, by country
(Thousand pounds and thousand dollars)

Destination	Ferrovanadium and other vanadium alloying materials containing over 6% vanadium (gross weight)				Vanadium ore, concentrates, pentoxide, vanadic acid, vanadium oxide and vanadates (except chemically pure grade) (vanadium content)			
	1974		1975		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	40	118	17	70	--	--	--	--
Austria	--	--	--	--	--	--	174	788
Belgium-Luxembourg	42	128	111	405	--	--	--	--
Brazil	53	169	--	--	12	35	--	--
Canada	1,198	3,527	745	3,055	3	13	6	27
China, Peoples Republic of	--	--	--	--	--	--	5	15
France	4	11	4	18	--	--	--	--
Germany, West	--	--	6	12	90	310	139	361
Hong Kong	7	21	--	--	--	--	--	--
India	(1)	1	135	452	--	--	--	--
Japan	200	557	160	587	235	722	55	207
Malaysia	1	3	1	2	--	--	--	--
Mexico	194	423	--	--	24	84	52	230
Netherlands	454	1,488	388	1,618	--	--	--	--
Philippines	--	--	--	--	42	163	--	--
Poland	44	126	--	--	--	--	--	--
Spain	64	187	43	171	--	--	--	--
Sweden	359	1,081	304	1,022	--	--	--	--
Switzerland	10	23	63	284	--	--	--	--
Venezuela	--	--	59	256	--	--	--	--
Total	2,670	7,863	2,036	7,952	406	1,327	431	1,628

[1] Less than ½ unit.

Table 7.—U.S. imports of ferrovanadium, by country
(Thousand pounds and thousand dollars)

Country	1974			1975		
	Gross weight	Vanadium content	Value	Gross weight	Vanadium content	Value
General imports:						
Austria	--	--	--	77	53	294
Belgium-Luxembourg	220	162	640	--	--	--
Brazil	--	--	--	44	31	155
Canada	1	1	3	16	12	68
Germany, West	133	86	380	222	177	918
Norway	96	43	138	--	--	--
Total	450	292	1,161	359	273	1,435
Imports for consumption:						
Austria	--	--	--	77	53	294
Belgium-Luxembourg	r 220	162	640	--	--	--
Brazil	--	--	--	44	31	155
Canada	1	1	3	16	12	68
Germany, West	r 129	82	361	222	177	918
Norway	96	43	138	--	--	--
Total	446	288	1,142	359	273	1,435

r Revised.

Table 8.—U.S. imports of vanadium pentoxide (anhydride), by country
(Pounds and dollars)

Country	1974			1975		
	Gross weight	Vanadium content	Value	Gross weight	Vanadium content	Value
General imports:						
Canada	--	--	--	1,682	942	303
Finland	60,075	33,654	108,569	44,974	25,194	124,209
Germany, West	44,259	24,794	35,285	99,498	55,739	241,319
Mozambique	61,218	34,294	100,766	--	--	--
South Africa, Republic of	1,738,628	973,979	2,686,155	4,404,727	2,467,528	7,940,330
United Kingdom	2	1	554	1	(1)	255
Total	1,904,182	1,066,722	2,931,329	4,550,882	2,549,404	8,306,416
Imports for consumption:						
Canada	--	--	--	1,682	942	303
Finland	60,075	33,654	108,569	44,974	25,194	124,209
Germany, West	44,259	24,794	35,285	99,498	55,739	241,319
Mozambique	61,218	34,294	100,766	--	--	--
South Africa, Republic of	1,738,628	973,979	2,686,155	4,151,148	2,325,473	7,507,710
United Kingdom	2	1	554	1	(1)	255
Total	1,904,182	1,066,722	2,931,329	4,297,303	2,407,349	7,873,796

[1] Vanadium content 0.6 pounds.

WORLD REVIEW

In addition to the nations listed in table 9, some others had relatively small vanadium production from secondary, waste, or byproduct sources. Japan and West Germany produced vanadium from several such sources.

Australia.—The Barrambie project of Ferrovanadium Corp. N.L. was reportedly approaching the pilot plant stage.[2] This project would lead to the exploitation of a large vanadium-titanium-iron deposit, the initial discovery of which was made in 1960 as the result of an airborne survey. Since 1971, drilling of the area and other geophysical and geological work has been undertaken. Indicated ore reserves are put at some 30 million tons of ore containing an average of 0.7% V_2O_5, 15% TiO_2, and 26% Fe, while inferred reserves of unspecified grade are estimated at some 448 million tons.

[2] Mining Magazine (London). Progress at W. Australian Vanadium/Iron Project. V. 133, No. 5, November 1975, pp. 339 and 341.

Table 9.—Vanadium: World production from ores and concentrates, by country
(Short tons of contained vanadium)

Country	1973	1974	1975 [p]
Chile [e]	1,060	[r] 640	660
Finland (in vanadium pentoxide product)	1,388	1,635	1,405
Norway [e]	[r] 820	[r] 850	1,140
South Africa, Republic of: [1]			
Content of pentoxide and vanadate products [e]	[r] 3,789	[r] 3,657	5,300
Content of vanadiferous slag product [e]	[r] 5,258	[r] 5,327	6,434
Total	9,047	8,984	11,734
South West Africa, Territory of: (in lead vanadate concentrate) [2]	715	903	619
U.S.S.R. (in slag exports only)	4,246	[r] [e] 3,230	[e] 3,530
United States (recoverable vanadium)	4,377	4,870	4,743
Total	[r] 21,653	21,112	23,831

[e] Estimate. [p] Preliminary. [r] Revised.
[1] The Republic of South Africa officially reported the undistributed total production of vanadium in pentoxides and vanadate products as well as in vanadium bearing slags. Data on vanadium content of vanadium slag is estimated on the basis of a reported tonnage of vanadium-bearing slag (gross weight) multiplied by an assumed grade of 14% vanadium. Vanadium content of pentoxide and vanadate products represents the difference between the reported total and the calculated estimate for vanadium in slag.
[2] Data represent output of South West Africa Co. Ltd. for years ending June 30 of that stated.

Canada.—Research on a metallurgical process that would permit the recovery of some of the elements contained in the Magpie deposits, located about 80 miles north of Mingana, Quebec, was conducted by the Quebec Department of Natural Resources and the Canada Centre for Mineral and Energy Technology (CANMET), Department of Energy, Mines and Resources. These deposits contain more than 1 billion tons of titaniferous magnetite grading 43% Fe, 10.5% TiO_2, 1.6% Cr, and small amounts of vanadium, nickel, and aluminum. The Quebec Department of Natural Resources also was working on an ilmenite-magnetite deposit located in the Lac Doré area of Chibougamau, Quebec, that contains 1.3% vanadium.[3]

The principal consumers of vanadium in Canada are The Algoma Steel Corp., Ltd.; Atlas Steels Co. Division of Rio Algom Mines Ltd.; Burlington Steel Division of Slater Steel Industries Ltd.; Sydney Steel Corp. (Sysco); Dominion Foundries & Steel, Ltd. (Dofasco); Sidbec-Dosco Ltd.; Manitoba Rolling Mills Division of Dominion Bridge Co. Ltd.; The Steel Co. of Canada, Ltd (Stelco); and Colt Industries (Canada) Ltd.[3]

Finland.—According to Finnish trade statistics, Finland exported 2,955 tons of vanadium compounds[4] in 1974, compared with 2,594 tons in 1973. Of the 2,955 tons, 714 tons went to Sweden, 638 tons to West Germany, 623 tons to France, 331 tons to the U.S.S.R., 307 tons to Great Britain, 120 tons to Czechoslovakia, 89 tons to Brazil, 55 tons to Canada, 44 tons to Iceland, 30 tons to the U.S.A., and 1.7 tons each to Austria and Italy.

Rautaruukki Oy reported an output of 2,509 tons (gross weight) of vanadium pentoxide in 1975, compared with 2,918 tons (gross weight) in 1974.

Germany, West.—According to official trade statistics, West Germany imported 29,674 tons (gross weight) of vanadium-containing ashes, residues, and slag in 1975, compared with 32,848 tons (gross weight) in 1974.

India.—Vanadium was reported[5] as having been extracted on an industrial scale from local ores using a process developed by the National Metallurgical Laboratory and the State-owned Mysore Iron & Steel Ltd. The vanadiferous ore lies near Masanikeri, some 40 miles from the Mysore Iron & Steel works at Bhadravati.

Italy.—Italsider S.p.A. has adopted a vanadium-columbium steel (yield strength 70,000 pounds per square inch) for the production of pipe of 48 inches and 56 inches in diameter, with wall thicknesses up to 15 millimeters. The steel was developed in conjunction with the Vanadium International Technical Committee (Vanitec). The first experimental pipes were

[3] Boucher, Michel A. Vanadium. Dept. of Energy, Mines and Resources, Ottawa, Ontario, Canada. Sept. 1975, 5 pp.
[4] Although the title of the export class is "vanadium compounds," the material is almost all vanadium pentoxide.
[5] Metal Bulletin (London). Indian V Success. No. 6018, Aug. 22, 1975, p. 40.

made by Italsider at its Taranto Works in December 1974, and commercial production began early in 1975 after further developmental studies. Over 150,000 tons of pipe had been produced by mid-July. In addition to its strength, the steel reportedly met the severe requirements for weldability and resistance to brittle fracture that are prescribed for Arctic pipeline construction.[6]

South Africa, Republic of.—South Africa, the world's leading vanadium-producing country, increased its output in 1975. Statistics, as published by the South African Government's Department of Mines, are for the combined forms—slag, polyvanadate and metavanadate and fused pentoxide as V_2O_5. In this combined form, production in 1975 totaled 20,946 tons, compared with 16,049 tons in 1974 and 16,149 tons in 1973.

During the fiscal year ending June 30, 1975, Highveld Steel and Vanadium Corp., Ltd. (HSV), South Africa's and the world's leading producer of vanadium, produced at its Witbank plant a total of 45,955 tons (gross weight) of vanadium-bearing slag, compared with 38,053 tons (gross weight) in the previous fiscal year; the company's Vantra Division produced fused vanadium pentoxide. A new primary crushing and washing section was installed[7] at HSV's Mapochs mine (near Roosenekal) to facilitate the handling of run-of-mine ore of a higher clay content than that formerly mined and to meet the higher tonnage called for by the corporation's Witbank works. Capacity of the ore treatment plant was increased from 300 to 475 tons per hour.

South Africa's second most important producer of vanadium, Ucar Minerals Corp. (wholly-owned subsidiary of Union Carbide Corp.), continued to produce vanadium pentoxide at Bon Accord near Pretoria from ore obtained from the Brits area.

A third producer, Transvaal Alloys Ltd., that began production of vanadium pentoxide in 1974 will expand its operations within a 5-year period if export sales (largely to Japan's Taiyo Koko K.K. and to West Germany) improve as envisaged in 1975.

Thermometallurgical Corp., (Pty) Ltd., produced ferroalloys, including ferrovanadium, at its Benoni plant. A total capacity of up to 1,200 tons per year for all alloys was reported[8] for this plant.

South-West Africa (International Territory).—The South West Africa Co., Ltd. (Swaco), continued to produce lead vanadate concentrate from the Berg Aukas mine, near Grootfontein. During the fiscal year ending June 30, 1975, the grade of the ore mined and hoisted was adversely affected by a decrease in the quantity of vanadium-rich cavity-fill material available for treatment. Production dropped 31% from 9,202 tons of lead vanadate concentrate in fiscal year 1974 to 6,361 tons in fiscal year 1975. On June 30th, 1975, about 1,323 tons of lead vanadate concentrate was held in the pipeline between the mine and the smelter in West Germany.

TECHNOLOGY

The Bureau of Mines published part 1 of a study on the use of nitride intermediates in the preparation of columbium, vanadium, and tantalum metals.[9] The objective of laboratory research at the Boulder City Metallurgy Research Laboratory reported in part 1 was to study the rate and degree of nitride conversion of the oxides of these metals with ammonia preparatory to use of the nitride to produce the respective metals; to optimize experimental conditions; and to obtain a nitride product as low as possible in oxygen in the shortest practical time. Variables examined included reactor material, temperature, space velocity and composition of the nitriding gases, and composition, particle size, and thermal treatment of the oxides. Most of the nitride conversion data reported were generated from single experiments. The best nitride conversions were obtained in nonmetal reactors.

Use of electrorefined vanadium metal prepared at the Bureau of Mines Boulder City Metallurgy Research Laboratory was

[6] Metal Bulletin (London). Vanadium Steel in Pipelines. No. 6007, July 15, 1975, p. 26.

[7] Coal Gold + Base Minerals of Southern Africa. Mapochs: Rlm Plant Means 40% Expansion. V. 23, No. 8, October 1975, pp. 20–21, 23.

[8] Metal Bulletin. Ferro-Alloys Survey, 1975. P. 127.

[9] Guidotti, R. A., G. B. Atkinson, and D. G. Kesterke. Nitride Intermediates in the Preparation of Columbium, Vanadium, and Tantalum Metals (In Two Parts) 1. Nitride Preparation. BuMines RI 8079, 1975, 25 pp.

documented in two publications. One study[10] investigated the change in electrical resistivity of interstitial alloys as a function of the static displacement caused by the interstitials. The other study[11] involved determining constitution diagrams of noble metal alloys, including vanadium-ruthenium and vanadium-rhenium.

Vanitec, which continued to sponsor research on vanadium applications, published the first of a series of monographs, "Vanadium Steel Reinforcing Bars." Since its formation in 1973, Vanitec has sponsored research programs on high-strength steels in the United Kingdom at the National Physical Laboratory and the Welding Institute, and in Italy with the Centro Sperimentale Metallurgico and Italsider S.p.A. The committee consists of representatives from the following major producers of vanadium ores, concentrates, alloys and other compounds: Awamura Metal Industry Ltd., Billiton Phibro B.V., BOC Murex, Continental Alloys S.A., Climax Molybdenum Co., Elkem Spigerverket A/S, Foote Mineral Co., Highveld Steel and Vanadium Corp., Metallurg, Inc., Nippon Denko KK, Rautaruukki Oy, Sadacem, Société Française d'Electrométallurgie (Sofrem), South West Africa Co., Taiyo Mining, Termoligas Metalurgicas S.A., Treibacher Chemische Werke AG, and Union Carbide Corp.

A method for recovering vanadium from certain iron ores without sodium or alkali contamination was developed and patented.[12] Vanadium-bearing iron ore is mixed with a calcium-bearing compound such as limestone; the mixture is roasted in an oxidizing atmosphere to form calcium vanadates, which are relatively insoluble in water but can be leached with an aqueous solution containing carbonate or bicarbonate compounds, preferably ammonium carbonate or bicarbonate. Use of ammonium compounds is reported to produce a sodium-free vanadium product. Other insoluble calcium compounds produced during roasting remain with the leached iron ore residue, which can be processed to recover the iron.

A patent was issued for extraction of vanadium values from vanadiferous slag from the manufacture of steel or iron from ores containing vanadium as an impurity. A mixture of slag and sodium carbonate was heated between 600° to 800° C in a convertor in the presence of oxygen to solubilize the vanadium, the reaction product leached with water, and the vanadium values recovered from the leach.[13]

Another patent covered a process for extraction of vanadium and titanium values from slag formed by smelting iron oxide which contains substantial percentages of vanadium and titanium. A mixture of slag and sodium chloride was heated between 1300° to 1700° C to form an altered slag. The altered slag was oxidized by salt-roasting in an oxidizing atmosphere to solubilize vanadium oxide in the plus-five valence state, the slag leached, and the leach solution processed for vanadium. Titanium was recovered from the low-vanadium residue by known methods.[14]

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[10] McIntire, W. R., and J. B. Cohen. Static Distortions and Resistivity Due to Interstitials. Acta Metallurgica, v. 23, No. 8, August 1975, pp. 953–956.

[11] Waterstrat, R. M., and R. C. Manuszewski. Noble Metal Constitution Diagrams: Part II. National Bureau of Standards NBSIR 73–415, August 1975, 171 pp.

[12] Bare, C. B., and J. W. Pasquali (assigned to Bethlehem Steel Corp.). U.S. Pat. 3,853,982, Dec. 10, 1974.

[13] Peters, F. J. W. M., S. Middelhoek ,and A. Rijkelboer (assigned to Billiton Research B.V.). U.S. Pat. 3,929,460, Dec. 30, 1975.

[14] Miyoshi, T. K., C. E. Berthold, F. M. Stephens, Jr., and A. K. Schellinger (assigned to Ferrovanadium Corp., N.L.). U.S. Pat. 3,929,461, Dec. 30, 1975.

Vermiculite

By Richard H. Singleton [1]

Crude vermiculite output totaled 330,000 tons in 1975, a decline of 3% from that produced in 1974. World production of crude increased 4% in 1975 to approximately 577,000 tons. Domestic output of exfoliated vermiculite declined 15% to 235,000 tons. Vermiculite was exfoliated at 51 plants in 29 States using mainly domestic crude but also crude imported from the Republic of South Africa. Two exfoliation plants closed in 1975. Exfoliated vermiculite continued to be used mainly in the building industry as concrete aggregate, as premixes for acoustic, fireproofing, and other purposes, and as loose-fill and block insulation. Demand for these lightweight products continued to decrease in accord with a decline in building activity.

Table 1.—Salient vermiculite statistics
(Thousand short tons and thousand dollars)

	1971	1972	1973	1974	1975
United States: Sold and used by producers:					
Crude	301	337	365	341	330
Value	$7,198	$8,092	$9,464	$10,120	$13,761
Average value per ton	$23.91	$24.01	$25.93	$29.68	$41.70
Exfoliated	209	247	293	275	235
Value	$20,885	$24,777	$31,186	$30,916	$36,345
Average value per ton	$99.93	$100.31	$106.44	$112.42	$154.66
Exports to Canada	29	31	36	44	45
Imports from the Republic of South Africa	18	26	30	42	33
World:					
Production, crude	459	512	r 549	r 555	577

r Revised.

DOMESTIC PRODUCTION

Crude Vermiculite.—Output of vermiculite concentrate, commonly called crude, decreased from 341,000 tons in 1974 to 330,000 tons in 1975. Capacity of W. R. Grace & Co.'s beneficiation mill at Libby, Mont., was increased. W.R. Grace & Co. also continued to mine and beneficiate vermiculite near Enoree, S.C. In addition, Patterson Vermiculite Co. continued to produce a small tonnage at Lanford, S.C. Plans of W. R. Grace & Co. to develop vermiculite deposits near Louisa, Va., remained shelved during 1975, mainly as a result of zoning problems.

Exfoliated Vermiculite.—The tonnage of exfoliated vermiculite sold or used decreased 15% to 235,000 in 1975. Leading States, accounting for 42% of the exfoliated vermiculite sold or used, were California, Florida, New Jersey, South Carolina, and Texas. W. R. Grace & Co., Construction Products Div., the principal producer of crude vermiculite, operated 30 exfoliating plants in 24 States. Crude vermiculite imported from the Republic of South Africa was exfoliated in 11 domestic plants. The other 10 domestic exfoliating plants used domestic crude as feedstock. The sources of crude for domestic exfoliated vermiculite sold and used were Libby, Mont., 47%; South Carolina, 44%; and the Republic of South Africa, 9%.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 2.—Vermiculite exfoliating plants in the United States in 1975

Company	State	County	Nearest city or town
J. P. Austin Assoc., Inc	Pennsylvania	Beaver	Beaver Falls.
J. J. Brouk & Co., Inc	Missouri	St. Louis	St. Louis.
Carolina Wholesale Florists, Inc	North Carolina	Lee	Sanford.
Cleveland Builders Supply Co., Cleveland Gypsum Co. Div.	Ohio	Cuyahoga	Cleveland.
Diversified Insulation, Inc	Minnesota	Hennepin	Minneapolis.
W. R. Grace & Co., Construction Product Div.	Arizona	Maricopa	Phoenix.
	Arkansas	Pulaski	North Little Rock.
	California	Alameda	Newark.
		Los Angeles	Los Angeles.
		Orange	Santa Ana.
	Colorado	Denver	Denver.
	Florida	Broward	Pompano Beach.
		Duval	Jacksonville.
		Hillsborough	Tampa.
	Illinois	DuPage	West Chicago.
	Kentucky	Campbell	Newport.
	Louisiana	Orleans	New Orleans.
	Maryland	Prince Georges	Muirkirk.
	Massachusetts	Hampshire	Easthampton.
	Michigan	Wayne	Dearborn.
	Minnesota	Hennepin	Minneapolis.
	Missouri	St. Louis	St. Louis.
	Nebraska	Douglas	Omaha.
	New Jersey	Mercer	Trenton.
	New York	Cayuga	Weedsport.
	North Carolina	Guilford	High Point.
	Oklahoma	Oklahoma	Oklahoma City.
	Oregon	Multnomah	Portland.
	Pennsylvania	Lawrence	New Castle.
	South Carolina	Greenville	Kearney.
		do	Travelers Rest.
	Tennessee	Davidson	Nashville.
	Texas	Bexar	San Antonio.
		Dallas	Dallas.
	Wisconsin	Milwaukee	Milwaukee.
Hyzer & Lewellen	Pennsylvania	Bucks	Southampton.
International Vermiculite Co	Illinois	Macoupin	Girard.
Koos, Inc	Wisconsin	Kenosha	Kenosha.
La Habra Products, Inc	California	Orange	Anaheim.
MacArthur Co	Minnesota	Ramsey	St. Paul.
Mica Pellets, Inc	Illinois	De Kalb	De Kalb.
Patterson Vermiculite Co	South Carolina	Laurens	Lanford.
Robinson Insulation Co	Montana	Cascade	Great Falls.
	North Dakota	Ward	Minot.
Schmelzer Sales Associates, Inc	Florida	Hillsborough	Tampa.
The Schundler Co	New Jersey	Middlesex	Metuchen.
Strong-Lite Products	Arkansas	Jefferson	Pine Bluff.
Supreme Perlite Co	Oregon	Multnomah	Portland.
Vermiculite of Hawaii, Inc	Hawaii	Honolulu	Honolulu.
Vermiculite-Intermountain, Inc	Utah	Salt Lake	Salt Lake City.
Vermiculite Products, Inc	Texas	Harris	Houston.

CONSUMPTION AND USES

The use pattern for exfoliated vermiculite by main categories showed no major change from 1974 and was as follows: Aggregates, 50%; insulation, 31%; agriculture, 16%; and miscellaneous, 3%.

Demand for smaller flake sizes decreased. Almost no demand existed for flake sizes below 65 mesh.

An end use breakdown is shown in thousand tons in the following tabulation:

Use	1974	1975
Aggregates:		
Concrete	94	75
Plaster	5	4
Premixes [1]	42	38
Total	141	117
Insulation:		
Loose-fill	47	39
Block	32	35
Packing	1	--
Total	80	74
Agriculture:		
Horticulture and soil conditioning	40	31
Fertilizer carrier	7	7
Other	--	--
Total	47	38
Miscellaneous	6	6
Grand total	274	235

[1] Includes vermiculite used in premixes for acoustic and fireproofing purposes, decorative textures, moisture sealant, etc.

PRICES

According to the Bureau of Mines canvass, the average value of domestic crude vermiculite increased 40% over the 1974 value to $41.70 per ton. The average value of exfoliated vermiculite increased 38% to $154.66 in 1975. These values are f.o.b. mine or plant.

Engineering and Mining Journal quoted nominal yearend prices for crude vermiculite as follows: Per short ton, f.o.b. mine, domestic crude, $38 to $63; and c.i.f. Atlantic ports, the Republic of South Africa crude, $60 to $80.

FOREIGN TRADE

Approximately 33,000 tons of crude vermiculite was imported duty-free into the United States from the Republic of South Africa, a 21% decrease under that imported in 1974. A total of 45,123 tons of crude was exported from the United States to Canada, primarily from Libby, Mont., a 2% increase over that exported in 1974.

WORLD REVIEW

Canada.—A total of 61,307 tons of crude vermiculite was imported in 1975, mostly from Montana and some from the Republic of South Africa, a 24% increase over that imported in 1974. Grace Construction Materials Ltd. operated exfoliating plants in 1974 at St. Thomas and Ajax, Ontario; Winnipeg, Manitoba; and Vancouver, British Columbia. F. Hyde & Co., Ltd. and Vermiculite Insulating Ltd. operated exfoliating plants at Montreal, Quebec, and Lachine, Quebec, respectively. Northern Perlite and Vermiculite Ltd. began operation in 1974 of an exfoliation plant at St. Boniface, Manitoba. The use pattern in 1974 was loose insulation, 75%; insulating concrete, 4%; insulating plaster, 2%; agriculture, 8%; and miscellaneous, 11%.[2]

South Africa, Republic of.—Crude vermiculite production capacity in the Transvaal, Republic of South Africa, was increased significantly. Actual production of crude increased 14% in 1975 to 228,761 tons. Total exports of crude increased 24% in 1975 to 205,000 tons. Nearly one-quarter of these exports went to the United States and Canada, and most of the balance was sent to Western Europe.

[2] Stonehouse, D.H. Lightweight Aggregates, 1974. Dept. Energy, Mines, and Resources, Ottawa, 1975, 6 pp.

Table 3.—Republic of South Africa: Exports of vermiculite, by country
(Short tons)

Country	1973 [1]	1974 [1]	1975 [2]
Australia	4,034	NA	
Austria	NA	1,418	NA
Belgium	1,696	2,283	
Canada	NA	NA	16,184
Denmark	787	983	
Finland	1,887	623	
France	16,525	19,724	
Germany, West	14,356	16,507	
Ireland	1,375	2,433	
Israel	359	NA	
Italy	20,959	19,563	NA
Japan	11,405	NA	
Netherlands	1,091	1,313	
Portugal	NA	291	
Spain	4,145	4,146	
Sweden	3,164	3,220	
Switzerland	1,215	2,332	
United Kingdom	37,294	29,994	32,586
United States	30,345	[3] 47,571	33,000
Undisclosed	6,854	12,576	NA
Total [4]	157,491	164,977	204,965
Total value [4] [5]	$4,941,505	$5,597,584	NA
Average value per ton [5]	$31.38	$33.93	NA

NA Not available.
[1] Source unless otherwise noted: London Mining Journal. Mining Annual Review. 1975 and 1974, pp. 129 and 126.
[2] Data listed are from official trade returns of recipient countries.
[3] Includes Canada.
[4] Source: Republic of South Africa Department of Mines. Minerals, October-December 1974 and 1975 editions, p. 32.
[5] Converted to U.S. currency at the rate of 1 rand=$1.4438 for 1973 and $1.4722 for 1974.

Table 4.—Vermiculite: Free world production, by country
(Short tons)

Country	1973	1974	1975 p
Argentina	2,809	2,530	e 2,400
Brazil e	5,000	5,000	5,000
Egypt	24	67	e 80
India	r 2,986	3,109	2,400
Kenya	960	1,855	8,249
South Africa, Republic of	172,469	201,296	228,761
Tanzania	--	22	e 20
United States (sold or used by producers)	365,000	341,000	330,000
Total	r 549,248	554,879	576,910

e Estimate. p Preliminary. r Revised.

Zinc

By V. Anthony Cammarota, Jr.,[1] and Ronald J. DeFilippo [1]

With the lowered rate of economic activity in 1975, slab zinc consumption, mine and smelter production, Government stockpile releases, and imports of ores and concentrates all declined. Consumption of slab zinc, at 925,330 tons, decreased 28% from that of 1974.

Mine production was 469,355 tons, down 6% from that of 1974. Tennessee, New York, and Missouri were the major producing States accounting for one-half of domestic mine production. The New Jersey Zinc Co. began shipping concentrate from its new Elmwood mine in central Tennessee in January. In east Tennessee, ASARCO Incorporated shut down the Mascot mill in October and brought its new Young mill onstream. The Ontario mine in Utah began production in May. Callahan Mining Corp. and The New Jersey Zinc Co., through a joint venture, began developing a zinc-copper deposit in north-central Virginia.

Smelter production of primary slab zinc was 438,051 tons, down 21% from that of 1974, continuing the decline of zinc smelter production since 1969. National Zinc Co. was constructing a new electrolytic zinc plant in Bartlesville, Okla. to replace the old horizontal retort plant scheduled for closing in May 1976. The smelter was designed for a capacity of 56,000 tons per year. The New Jersey Zinc Co. and Union Minière of Belgium formed a joint venture to build a 90,000-ton-per-year electrolytic smelter at Clarksville, Tenn., for completion in 1979. Another zinc plant being planned by ASARCO at Stephensport, Ky., was postponed indefinitely. The company closed its 53,000-ton-per-year smelter at Amarillo, Tex. in May thereby reducing U.S. zinc smelting capacity to 652,000 tons per year.

Producer and consumer stocks were 250,878 tons on January 1, and climbed to 269,455 tons in April, the highest level in recent years. However, as smelter production declined and demand increased later in the year, stocks fell to 182,928 tons by yearend.

General imports of zinc in ores and concentrates decreased 40% from those of 1974 to 144,987 tons, of which Canada supplied about two-thirds of the total. Other major suppliers were Honduras, Mexico, and Nicaragua. Imports for consumption, however, more than tripled to 428,544 tons. General imports and imports for consumption of slab zinc were 380,437 tons and 374,922 tons, respectively, representing decreases of almost one-third from those of 1974. Canada was the leading source of general metal imports by providing 48% of the total, followed by Spain, 7%; Australia, 6%; and Finland, 5%.

The General Services Administration (GSA) shipped 5,886 tons of zinc from the Government stockpile in 1975. The last three quarters of the year were declared closed by GSA because of a high producer stock balance. Shelf-item commitments of 2,014 tons made in 1974 were cancelled during the year. The total amount of zinc authorized for sale at yearend was 172,000 tons.

In spite of the falling demand for zinc, the price during the year remained virtually unchanged at about 39 cents per pound for Prime Western zinc. The average for the year was 38.96 cents per pound. One company raised its price by 2 cents per pound, but was forced to rescind the increase when the other producers remained firm. The European producer price decreased from 38.58 cents per pound in January to 35.77 cents per pound in December, partly as a result of declining ex-

[1] Physical scientist, Division of Nonferrous Metals.

change rates. Several foreign producers began quoting prices on the basis of the U.S. dollar rather than of the British pound sterling because of pricing problems associated with currency alinements.

On August 9, 1975, the President signed Public Law 94–89 suspending the duty on zinc ores, concentrates, and zinc-bearing materials until June 30, 1978.

Legislation and Government Programs.—On August 9, Public Law 94–89 went into effect which suspended the duty on imported zinc ores, concentrates, drosses, waste and scrap, and other zinc-bearing materials until June 30, 1978.

In the first quarter of 1975, GSA sold 1,950 tons of zinc to producers but closed the last three quarters to any sales of zinc from stockpile excesses. GSA cited the high statistical position of producer stocks and its policy of not disrupting private sector markets. After shipments of 5,886 tons in 1975, total inventory was 385,714 tons at yearend. The uncommitted inventory was 374,830 tons of zinc including 172,130 tons available for disposal, and 202,700 tons as the strategic stockpile objective. The other 10,884 tons was committed to various Government agencies.

On November 17, the Environmental Protection Agency (EPA) put into effect interim effluent limitations for ore mining and processing facilities. After application of the best practical control technology currently available, water discharges from zinc mines were limited to a maximum of 1.0 milligram of zinc per liter for any one day, not to exceed an average of 0.5 milligram per liter over a 30-day period. Mills were not to exceed discharges of 0.4 milligram of zinc per liter and 0.2 milligram of zinc per liter on the same time basis.[2]

The Administrator of EPA promulgated regulations prescribing emission standards for copper, lead, and zinc smelters on December 30. Emissions of sulfur dioxide contained in gases discharged from roasters and from any sintering machine which eliminates more than 10% of the sulfur initially contained in the zinc sulfide concentrates processed are limited to 0.065% by volume (650 parts per million) averaged over a 2-hour period.[3]

The National Institute for Occupational Safety and Health (NIOSH) transmitted new criteria for zinc oxide exposure to the Occupational Safety and Health Administration. The NIOSH standards recommended that workers in contact with zinc oxide should not be exposed to a concentration of more than 5 milligrams of zinc oxide per cubic meter of air averaged over a 40-hour work week. Levels of 15 milligrams per cubic meter were not to be exceeded for more than 15 minutes at a time.

The International Lead and Zinc Study Group (ILZSG) held its 19th session in Geneva, Switzerland, November 3–8, to review developments in lead and zinc, and to consider projections for 1976. In its review of new mine and smelter projects a substantial increase in world zinc smelter projects was indicated, but there were also deferrals of some projects due to economic conditions. Subjects proposed for study by ILZSG included costs of processing lead and zinc, environmental costs, trade in scrap, and the extent of governmental aid to companies producing lead and zinc.

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[2] Federal Register. Ore Mining and Dressing Point Source Category. V. 40, No. 215, Nov. 6, 1975, pp. 51731–51732.

[3] Federal Register. Standards of Performance for New Stationary Sources. V. 41, No. 10, Jan. 15, 1976, pp. 2332–2341.

Table 1.—Salient zinc statistics

	1971	1972	1973	1974	1975
United States:					
Production:					
Domestic ores, recoverable content ----------- short tons --	502,543	478,318	478,850	499,872	469,355
Value --------------- thousands --	$161,819	$169,803	$197,861	$358,908	$366,097
Slab zinc:					
From domestic ores short tons --	403,750	400,969	399,119	346,993	307,959
From foreign ores ----- do ----	362,683	232,211	184,360	208,195	130,092
From scrap ---------- do ----	80,923	73,718	83,187	78,535	57,886
Total -----------------------	847,356	706,898	666,666	633,723	495,937
Secondary zinc [1] ---------- do ----	279,399	314,043	300,073	259,947	225,315
Exports of slab zinc ---------- do ----	13,346	4,324	14,566	19,062	6,897
Imports (general):					
Ores (zinc content) ------ do ----	342,521	254,868	199,634	240,043	144,987
Slab zinc ---------------- do ----	319,568	522,612	592,046	539,538	380,437
Stocks, December 31:					
At producer plants ------- do ----	48,574	30,068	25,947	39,720	75,652
At consumer plants ------ do ----	91,523	124,956	114,317	r 211,158	107,276
Government stockpile ----- do ----	1,137,937	949,583	677,009	391,600	385,714
Reprocessed GSA zinc [2] ------- do ----	NA	80,403	109,333	42,850	3,442
Consumption:					
Slab zinc ---------------- do ----	1,254,059	1,418,349	1,503,938	1,287,696	925,330
All classes --------------- do ----	1,650,694	1,844,023	1,931,925	1,673,013	1,231,815
Price: Prime Western cents per pound ----- (delivered) --	16.13	17.75	20.66	35.95	38.96
World:					
Production:					
Mine --------------- short tons --	6,079,365	5,992,071	r 6,293,484	r 6,281,047	6,131,082
Smelter ------------------ do ----	5,228,959	5,655,754	r 5,876,535	r 6,021,559	5,498,685
Price: Prime Western grade, London cents per pound --	14.08	17.13	38.55	56.13	33.76

r Revised. NA Not available.
[1] Excludes redistilled slab zinc.
[2] Included in total amount withdrawn from Government stockpile.

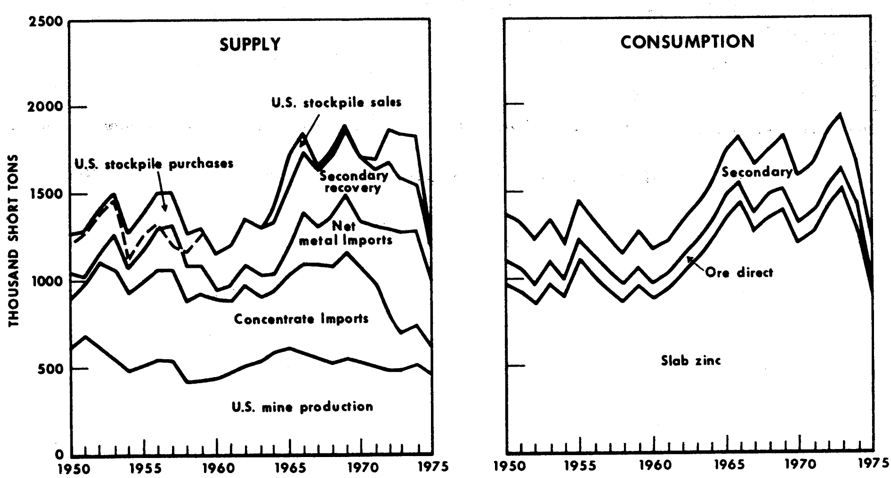

Figure 1.—Trends in supply and consumption in the United States.

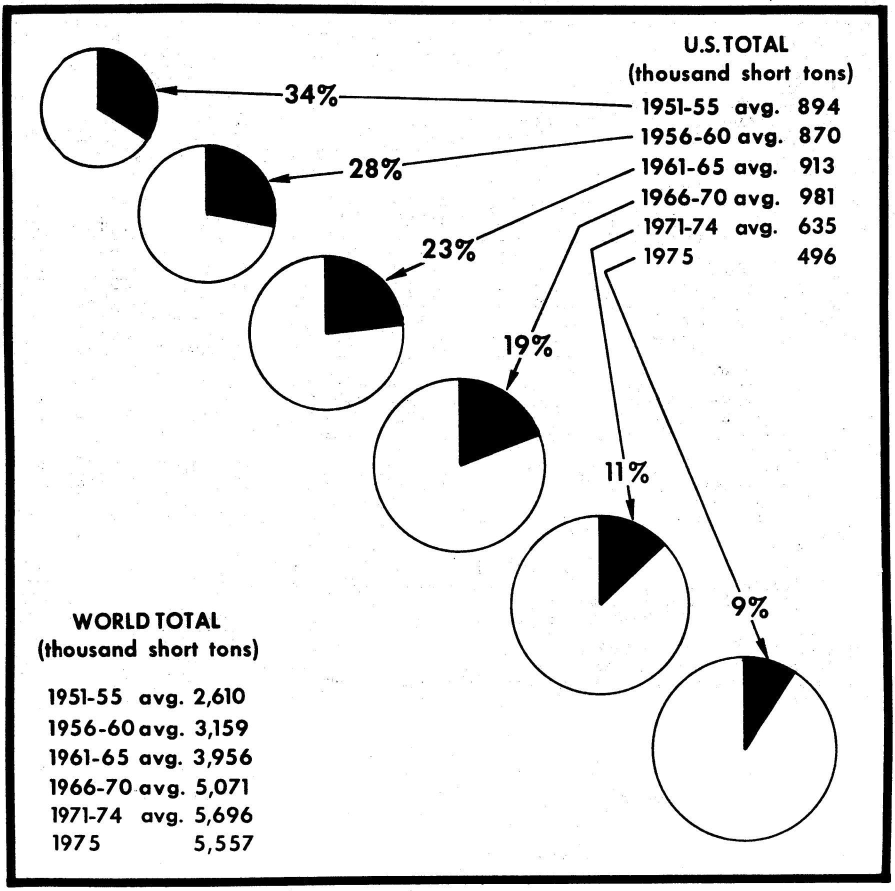

Figure 2.—Trends of United States percentage of world smelter production.

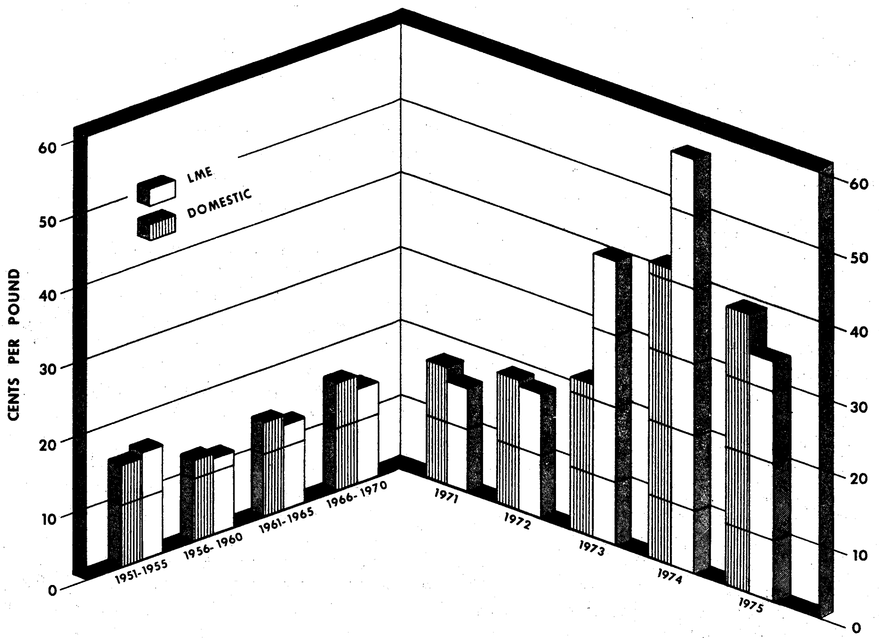

Figure 3.—Trends in average foreign and domestic zinc prices.

DOMESTIC PRODUCTION

MINE PRODUCTION

U.S. mine production from 19 States was 469,355 tons, a 6% decrease from that of 1974. Significant production increases were noted in Illinois, Nevada, Utah, and Washington. The major producing States in order of rank were Tennessee, 18%; New York and Missouri, 16% each; Colorado, 10%; and Idaho, 9%. All these States, except Idaho, showed lower production than in 1974. States east of the Mississippi accounted for about one-half of total U.S. mine production.

Zinc ore accounted for 52% of the total zinc production followed by zinc-lead ore, 21%; lead ore, 16%; copper-zinc and copper-lead-zinc ores, 7%; and other ores, 4%.

Table 6 shows the 25 leading U.S. zinc mines, which accounted for 87% of the recoverable domestic zinc mined in 1975. The five leading mines accounted for 40% of the total U.S. mine production.

Although Tennessee zinc mine production dropped 3% from that of 1974, the State displaced New York as the leading zinc producer. Eight mines produced zinc, all from zinc ores. The New Jersey Zinc Co. and Union Minière, S.A., of Belgium, formed a 60/40 joint venture in September called the Jersey Minière Zinc Co. The property to be developed by the venture includes some 3,000 acres around and including the first Elmwood mine, and a 3,000-ton-per-day mill which began processing development ore in mid-1974. All ore was being brought to the surface for milling at the Elmwood No. 1 shaft. The No. 2 shaft, about ½ mile to the east, was being used for service purposes. About 3½ miles to the southwest, a third shaft was sunk, the No. 3 or Gordonsville mine, which was joined by an incline to intersect ore to the north. A 9,000-ton-per-day mill near the No. 3 shaft was in the planning stage for possible completion by 1979. The No. 4 shaft was being sunk 1.5 miles south of Carthage. The No. 5 shaft was in the planning stage. New Jersey Zinc was independently developing its Lost Creek and Beaver Creek zinc properties in Jefferson County.

In east Tennessee, ASARCO increased its milling capacity by 20% with the opening of its new mill at the Young mine in September. The 8,500-ton-per-day facility will service all of ASARCO's east Tennessee zinc mines and was designed to replace the 1913-vintage Mascot mill, which formerly served this function. The mill has minimum disposal problems because all of the limestone which composes the host rock is sold for agricultural purposes or construction aggregate through the wholly-owned subsidiary, American Limestone Co. In addition, all process water is recycled. The zinc concentrate is used mainly for the production of zinc oxide at ASARCO's own plants in Ohio and Illinois. At Copperhill, Cities Service Co. extended the main shaft at the Calloway mine by 2,000 feet permitting access to a new crusher at the 33d level. A room approximately in the shape of a 30-foot cube was constructed at this level to house the crusher, and eliminate bringing ore up to the 23d level where the old crusher was located. Cities Service produced 9,200 tons of zinc concentrate, up 44% from 1974 production.

Toho Zinc Co. Ltd. and Nichimen Co. Ltd. agreed to a joint zinc exploration venture with Dresser Industries, Inc. in Tennessee and Kentucky. The interest centered mainly on a 25,000-acre concession in middle Tennessee. Zinc values were reported as high as 6%. St. Joe Minerals Corp. was also outlining zinc mineralization in Kentucky and Tennessee. A program of zinc exploration in Kentucky was suspended at midyear by ASARCO.

Zinc production as a coproduct from eight lead mines in Missouri fell 19% from that of 1974.

Production of zinc decreased 18% in New York where St. Joe Minerals Corp. operated the Balmat and Edwards mines. The Balmat mine retained its position as the nation's largest zinc producer. The Hyatt mine was reactivated to supplement ore from the Edwards mine where an estimated 4 years of minable ore remained.

In Colorado zinc production from 12 mines was 48,460 tons, down slightly from that of 1974. Idarado Mining Co., 80.1% owned by Newmont Mining Co., treated 406,000 tons of ore grading 3.24% zinc, 2.28% lead, 0.63% copper, and 0.3 and 1.50 ounces of gold and silver per ton, respectively. Costs increased because of increases in employee wages and benefits, smelter charges, and haulage distance within the mine. Resurrection Mining Co., wholly owned by Newmont Mining Co., produced 17,620 tons of zinc from the Leadville mine, a 15% increase over the 1974 level.

Zinc mine production was reported from 25 mines in Idaho where production remained about the same as that of 1974. The Bunker Hill Co., a wholly-owned subsidiary of Gulf Resources and Chemical Corp., mined approximately the same amount of ore as in 1974 from the Bunker Hill mine. Proven and probable reserves of zinc from the lead-zinc ore dropped 6% to 107,828 tons. Zinc production from the lead-zinc ores of the Star-Morning unit, owned 30% by Hecla Mining Co. and 70% by Bunker Hill, was about 16,000 tons, down 6% from 1974 production. Ore grade averaged 5.64% zinc, 5.0% lead, and 2.49 ounces of silver per ton. Average zinc grade dropped from 6.04% zinc, but the lead grade rose from 4.77%. Several new stopes were developed, mostly in short ore shoots and auxiliary veins. Most of the lateral development was done at the 7,700-foot level, but the No. 4 shaft was deepened to below the 7,900-foot level. A new pumping system and rock burst monitor were installed. Proven and probable reserves of zinc were 54,600 tons, down 11% from those of 1974. Hecla's Lucky Friday mine produced 2,234 tons of zinc, up 14% from that of 1974. Ore grade was 1.29% zinc, 10.71% lead, and 14.96 ounces of silver per ton. Lateral openings on the 4,250-foot level were completed and stope preparation was 60% accomplished. The main shaft was extended to the 4,660-foot level. The company reported its ore reserves at 505,000 tons.

Intermountain Mineral Engineers, Inc. with 50% participation by U.S. Antimony Corp., was rehabilitating the Nabob, Sydney, and Little Pittsburg mines in the Pine Creek area of the Coeur d'Alene mining district. A refurbishing program was undertaken at the 250-ton-per-day Nabob mill, which began intermittent production in June and milled 2,297 tons of ore on a custom basis. Custom milling would continue until production from the three mines can feed the mill to capacity. Development of the mines included a 60-foot raise on the Nabob 300 level; rehabilitation of the Sydney 600 level to remove gob; and 393 feet of diamond drilling, 150 feet of drifting, and construction of a 40-foot raise on the Little Pittsburg 600 level. A total of 1,450 tons of development rock was milled during the year. Probable and proven ore reserves at the Little Pittsburg mine were estimated by Intermountain to be 58,492 tons grading 13.92% combined lead and zinc, and 1.28 ounces of gold per ton. Reserves at old mine workings were estimated at 54,200 tons grading 10% combined lead and zinc and 1 ounce of gold per ton.

Utah production of zinc from two mines was 19,640 tons, a 56% increase over that of 1974. Park City Ventures, a joint venture owned 60% by The Anaconda Company and 40% by ASARCO, started its 750-ton-per-day concentrator at its lead-zinc-silver Ontario mine in April. New mineralization was encountered at the No. 3 shaft, No. 6 winze, and the silver fissure area. The Tintic Division of Kennecott Copper Corp. stated that it mined 13,800 tons of zinc.

Production was reported from one mine in Virginia, where production dipped 12%. Piedmont Mineral Associates, a joint venture of Callahan Mining Corp. (49%) and The New Jersey Zinc. Co. (51%), placed its Cofer mine at Mineral, Va., in development status in the third quarter. This new zinc-copper mine would be joined by the reactivation of one or two other mines in the area with the ores to be concentrated at a common mill at the Cofer site. Full production was set for mid-1978.

In Washington, production from the State's six mines increased over that of 1974. The Washington Zinc unit of Callahan Mining Corp. in northern Stevens County was placed in development status. Callahan's partners in the joint venture are United States Borax and Chemical Corp. and Brinco Ltd., both subsidiaries of Rio Tinto-Zinc Corp. Ltd. The venture was an extension of the old Van Stone lead-zinc body operated as an open-pit mine by the former American Smelting and Refining Co.

In Maine, the Blue Hill joint venture, 60% owned by Kerr-Addison Mines, Ltd. and 40% by Kerramerican, Inc., was the only zinc producer in the State. Mine production of recoverable zinc was 8,318 tons, down 20% from that of 1974. Total ore mined was 211,210 tons grading 4.9% copper and 4.9% zinc. Because of zinc smelter cutbacks, 7,150 tons of concentrate was stockpiled. Minable ore reserves of 522,000 tons grading 3.4% zinc were down 52% from those of 1974. Drilling in the Carlton area, south of the current workings, indicated reserves of 1.4 million tons of ore grading 8.19% zinc at a level of 700 to 1,200 feet below the present workings, but development was not contemplated.

Mine production of zinc from 3 mines in Wisconsin showed little change from that of 1974. Noranda Mines Ltd. announced the discovery of a copper-zinc massive sulfide deposit southeast of Rhinelander.

Arizona zinc production from seven mines was 8,655 tons, down 11% from that of 1974. Cyprus Mines Corp. produced 94,600 tons of ore grading 12.5% zinc and 3.73% copper from its Cyprus Bruce mine. Proven reserves were established at 196,000 tons.

In New Hampshire, Standard Metals Corp. began a drilling program near Milan in October as a followup of exploration which had been continuing since 1973. Low-grade zinc, copper, and lead mineralization was intersected with widths up to 150 feet. Encouraged by these results, Standard took an option on 240 square miles for further exploration expected to last at least 3 years.

SMELTER AND REFINERY PRODUCTION

U.S. slab zinc production at 7 primary plants and 13 secondary plants was 495,937 tons in 1975, a decrease of 22% from that of 1974. The decrease in production was attributable to the reduced level of economic activity during the year. The closing of ASARCO's zinc smelter at Amarillo, Tex., reduced domestic capacity to 652,000 tons per year.

Producer stocks increased sharply from 39,720 tons to 75,652 tons during the year. Domestic producers purchased 3,442 tons of GSA stockpile zinc during the year, all of which was remelted.

The portion of domestic slab zinc production from domestic ores was 62%, from foreign ores 26%, and from scrap 12%. Zinc produced from foreign ores decreased 38% from that of 1974, while production from domestic ores decreased 11%, and from scrap 26%.

Primary slab zinc produced at electrolytic refineries increased 2% over that of 1974, and was 47% of the total slab zinc produced. Zinc produced at retort plants was down 37% and made up 41% of the total. Redistilled slab zinc from secondary materials produced at primary smelters fell 38% and contributed 7% of the total; redistilled slab zinc at secondary smelters increased 3% and comprised 5% of the total. Distribution of slab zinc production by grades was Prime Western, 43%; Special High Grade, 49%; Intermediate, 3%; High Grade, 4%; and Brass Special, 1%.

The ASARCO zinc smelter at Amarillo, Tex., closed permanently on May 31, 1975. The old horizontal retort plant was considered obsolete and the cost of bringing the plant into compliance with clean air standards was regarded as prohibitive. In its 53 years of operation, the plant produced 2,094,345 tons of zinc, an annual average of nearly 40,000 tons. The 450 employees idled by the shutdown were largely absorbed by ASARCO's new copper refinery at Amarillo.

ASARCO issued a letter of intent to award a contract for the design of a new electrolytic refinery at Stephensport, Ky. The $160 million, 180,000-ton-per-year capacity zinc plant was to be built on a site already owned by ASARCO, but the actual construction date was suspended indefinitely.

National Zinc Co. continued construction of its Bartlesville, Okla., electrolytic smelter. The new $40 million smelter, rated at an annual capacity of 56,000 tons of slab zinc, was scheduled to replace the old 50,000-ton-per-year horizontal retort smelter at the same location by mid-June 1976. By yearend, purification and filtration buildings and facilities to house the melting and casting shops were completed. National Zinc had no plans to produce Special High Grade zinc, preferring to serve its traditional customers with lower grades, even though the standard product of electrolytic smelters is Special High Grade. National Zinc stated that by expanding the roaster capacity, smelter capacity may be increased by 15,000 tons in the future.

AMAX Zinc Co., Inc. continued to modernize its Sauget, Ill., electrolytic zinc plant. Full capacity of 84,000 tons of zinc was expected to be reached by the end of 1976. The plant produced 58,100 tons of zinc, all Special High Grade, in 1975. AMAX installed turbulent contact absorption towers for cooling the zinc electrolyte and completed the rebuilding of the electrolytic cell room. During 1975, AMAX spent $21.2 million of an alloted $26 million slated for the acquisition and modernization of the facility.

Bunker Hill produced 93,000 tons of slab zinc, a 1,000-ton increase from that of 1974. In August, Bunker Hill started operation of a State-approved sulfur dioxide abatement program designed to eliminate 72% of the sulfur dioxide emissions in the smelter stack gas. The plan required some curtailment of operations during adverse atmospheric conditions to prevent sulfur dioxide concentrations from exceeding ambient air standards. To overcome these restrictions, the company designed two new stacks, a 700-foot stack for the zinc smelter and a 610-foot stack for the lead smelter. In December, EPA displaced the Idaho regulations with stricter standards. Consequently, Bunker Hill filed for a judicial review and slowed construction on its $10 million stack project pending further negotiations. The completion of a $1.3 million program to capture dust from sintering operations was unaffected.

The New Jersey Zinc Co. and Union Minière, S.A. of Belgium, worked out partnership details for development of a new $97 million, 90,000-ton annual capacity zinc smelter at Clarksville, Tenn., scheduled for completion in 1979. New Jersey Zinc originally planned a 160,000-ton facility with completion set for 1976. The plant would be the first completely new domestic zinc refinery since 1941.

New Jersey Zinc also announced plans to consolidate all its research units at a new $3 million facility at Bethlehem, Pa. Studies will be conducted on ore evaluation, hydrometallurgy, extractive metallurgy, and chemical process technology. The 42,000-square-foot complex, named the Harold U. Zerve Research Center, was scheduled for completion by mid-1977.

By yearend, St. Joe Minerals Corp. spent $16.3 million of a $22.5 million bond issue sponsored in 1972 by a local development authority to finance water and air pollution controls on its Monaca, Pa. smelter. Another $14 million expenditure was anticipated to meet sulfur oxide and particulate emission control over the next 4 years with $2 million extra required for water pollution abatement.

The company-owned, coal-burning powerplant, which provides electricity for St. Joe's electrothermic smelter, was being considered as a demonstration project for the Federal Bureau of Mines citrate process for removing sulfur from stack emissions. St. Joe owns the coal mines which supply the powerplant.

Secondary Zinc Smelters.—Zinc recovered from zinc-bearing scrap was 283,201 tons in 1975, a 16% reduction from that recovered in 1974. Zinc-base scrap accounted for 58% of the total compared with 50% in 1974, while zinc recovered from copper-base scrap fell from 48% in 1974 to 41% in 1975. Recovery from new scrap continued to decrease, while that from old scrap continued to gain, the latter accounting for 27% of the total zinc recovered from scrap versus 22% in 1974. Of the total zinc recovered from scrap, 34% was recovered as zinc metal, 55% as alloys, mostly brass and bronze, and 11% as compounds, mostly zinc oxide.

Slag-Fuming Plants.—Slag-fuming plants processed hot and cold lead blast furnace slags and residues to produce zinc oxide fume. The oxide was either sold and used as oxide or sent to smelters and refineries for processing into metallic zinc. Three plants operated in 1975 as in 1974: ASARCO at El Paso, Tex., and East Helena, Mont., and The Bunker Hill Co., at Kellogg, Idaho.

Byproduct Sulfuric Acid.—In 1975, there were seven plants that roasted zinc sulfide concentrates and produced sulfuric acid, with one plant operating solely to produce calcine for processing to zinc oxide or slab zinc. In 1975, production of byproduct sulfuric acid from zinc plants was 711,769 tons, down from 830,969 tons produced in 1974.

Zinc Dust.—Production of zinc dust decreased 19% from that of 1974 to 40,875 tons in 1975. Zinc dust from distilled scrap accounted for 35,479 tons.

CONSUMPTION AND USES

About 620 facilities were canvassed for zinc consumption in 1975, compared with 670 in 1974. Of the total, 562 reported consuming zinc in 1975.

In 1975, slab zinc consumption declined 28% from that of 1974, and was off 38% from its high of 1,503,938 tons in 1973, a result of the economic slowdown that began in 1974 and continued into 1975. Industries that are large zinc consumers, such as automotive and housing, declined 31% and 43%, respectively, from 1973 to 1975.

Domestic consumption of slab zinc was 925,330 tons in 1975. The zinc content of the ore used directly in galvanizing or compounds was 82,732 tons, down from 127,113 tons in 1974. The zinc content of secondary materials to make alloys, zinc dust, and compounds was 223,753 tons, down from 258,204 tons in 1974. Total consumption of zinc for all classes was 1,231,815 tons, a decrease of 26% from that of 1974.

Slab zinc for galvanizing accounted for 376,887 tons (41%); zinc-base alloys, 334,191 tons (36%); brass products, 115,326 tons (12%); zinc oxide, 39,020 tons (4%); rolled zinc, 27,308 tons (3%); and other, 32,598 tons (4%).

Slab zinc consumption distributed by grade was Special High Grade, 438,173 tons (47%); High Grade, 83,369 tons (9%); Intermediate, 14,242 tons (2%); Brass Special, 79,214 tons (9%); Prime Western, 309,564 tons (33%); and Remelt, 768 tons (less than 0.1%). Consumption of all grades of slab zinc decreased from that of 1974. The most significant decline was that in Special High Grade zinc, which showed a loss of 134,678 tons, or 24%.

Slab zinc consumed at rolling mills was 27,308 tons in 1975, a decrease of 31% from that of 1974. Production of rolled zinc products decreased 28% to 27,725 tons. Strip and foil accounted for 76%, while 10% was used for photoengraving plates. Exports of wrought zinc decreased 53% to 1,629 tons, and imports decreased from 640 tons in 1974 to 236 tons. Production of rolled zinc from scrap was 22,153 tons in 1975, yielding a total production of 49,878 tons of rolled zinc during the year, compared with 71,891 tons in 1974.

The leading zinc consuming States in 1975 were Ohio with 129,254 tons (14%); Illinois, 123,067 tons (13%); Pennsylvania, 114,842 tons (12%); Indiana, 96,928 tons (10%); New York, 85,431 tons

(9%); and Michigan, 75,035 tons (8%). Ohio ranked highest in galvanizing and Michigan was the leader in diecasting.

In 1975, the Zinc Institute, Inc. conducted a survey of 438 diecasters to determine the consumption of zinc in 9 major market categories based on 1974 data. The results showed that automotive components accounted for 51.2% of the total; builders' hardware, 19.1%; domestic appliances, 8.5%; industrial, agricultural, and commercial machinery, 7.7%; electrical components, 5.7%; sporting goods and toys, 2.8%; scientific and professional equipment, 1.6%; sound and television equipment, 1.2%; and miscellaneous, 2.2%.

ZINC PIGMENTS AND SALTS

Production.—Published data for zinc pigments and compounds include zinc oxide and zinc sulfate. To avoid disclosing individual company confidential data, information for leaded zinc oxide, lithopone, and zinc chloride cannot be published.

Production of zinc oxide in 1975, at 165,400 tons, decreased 35% from that of 1974. Shipments were 2% higher than production. Zinc sulfate production, at 21,207 tons, showed a decrease of 54%.

The source of domestic zinc oxide production was 56% from ore and concentrate (American process), 29% from slab zinc (French process), and 15% from secondary material. Zinc sulfate production came from secondary material and from ore or intermediate products. Lead-free zinc oxide was produced at 14 plants in the United States, and leaded zinc oxide was produced at 1 plant. At least seven plants produced zinc sulfate and four produced zinc chloride.

Production of zinc oxide published by St. Joe Minerals Corp. was 46,914 tons, or 52% of capacity, down from 67,217 tons in 1974. Two other producers using ores or concentrates as a major source material were ASARCO with plants at Columbus, Ohio, and Hillsboro, Ill., and The New Jersey Zinc Co. Other major zinc oxide producers such as the Eagle-Picher Industries, Inc., Hillsboro, Ill., plant and the Sherwin-Williams Co., Coffeyville, Kans., plant, used calcines, fume, and secondary materials as raw materials. ASARCO, New Jersey Zinc, and St. Joe were the three producers of French process zinc oxide.

Consumption and Uses.—The apparent consumption of zinc oxide decreased 27% in 1975 to about 180,000 tons. Analysis of domestic shipments by industry usage showed the largest consumers to be the rubber industry with 57% of the total; photocopying, 15%; chemicals, 10%; and paints, 6%. The use of zinc oxide decreased in all categories. Agricultural use showed the largest decline, 70%, followed by chemicals, 50%; and ceramics, 48%. The large decline in agriculture shipments was attributed to consumers working down the excessive stock built up in the preceding year. Zinc oxide was also used in floor coverings, fabrics, lubricants, plastics, and rayon manufacturing. Agriculture was the chief use for zinc sulfate with lesser amounts assigned to rayon, flotation reagents, and chemicals. Leaded zinc oxide was used in rubber. Zinc chloride usage, a small part of zinc compound consumption, declined. Most of the chloride was used in soldering fluxes and batteries.

Prices.—Zinc oxide and compound prices remained stable during the year. For the first 4 months of 1975, prices ranged from 40 cents per pound for American process zinc oxide to 41.5 cents for French process zinc oxide, and from 42 to 44 cents for electrophotographic grade. Zinc oxide prices in April steadied at the higher end of the range after the March increase. In May, prices advanced to 40 to 41.75 cents for American process, 41.5 to 42.5 cents for French process, and 39 to 44 cents for electrophotographic grade. In July, electrophotographic grade climbed to 43 to 44 cents. At the end of the year quotations were 40 to 41 cents for American process, lead-free pigment grade, 41.5 cents for French process, and 43 to 44 cents for electrophotographic grade. Leaded zinc oxide, 12%, was quoted at 35.5 cents per pound compared with 37.25 cents in January 1975. The price of zinc sulfate, granular monohydrate industrial, 36% zinc, bags in car load lots, was reported as $24 to $26.50 per 100 pounds in December, up from $24 per 100 pounds a year earlier.

Foreign Trade.—Exports of zinc oxide decreased 75% from that of 1974 to 3,104 tons, of which 2,389 tons was pigment grade. Canada and Mexico received about 60% of the total. Lithopone exports decreased by 23% to 917 tons. Imports of almost all classes of zinc compounds decreased in 1975 to a total of 18,447 tons, a 53% loss. As in 1974, zinc oxide, although it declined 49% to 13,817 tons, was the major component of imports of zinc compounds. Mexico and Canada supplied 99% of the total with European Community countries contributing most of the remainder.

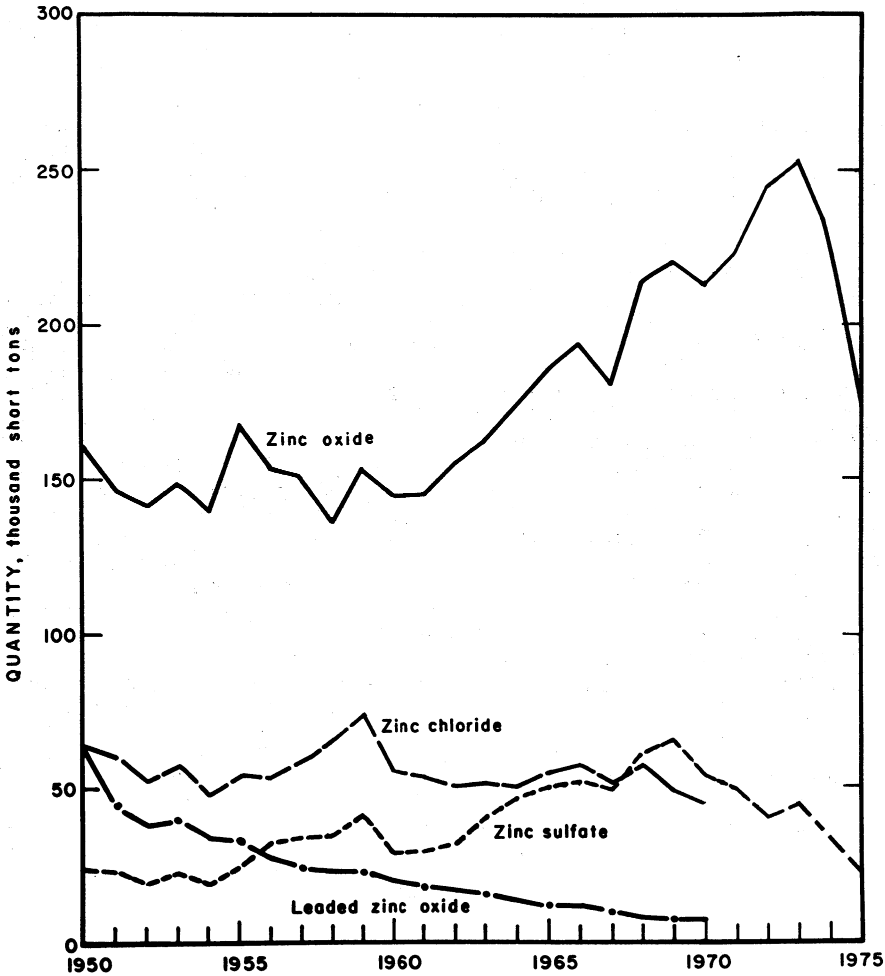

Figure 4.—Trends in shipment of zinc pigments.

STOCKS

Producer Stocks.—Stocks of slab zinc at producer plants at the beginning of the year were 39,720 tons, increasing to 75,652 tons by yearend. The Zinc Institute, Inc. reported that producer stocks climbed steadily to almost 116,000 tons in June, but then declined for the remainder of the year.

Consumer Stocks.—Slab zinc inventories at consumer plants were 211,158 tons at the beginning of the year, but by yearend consumer stocks had fallen to 107,276 tons. In the January to September period, consumer stocks fell to about 91,000 tons.

Government Stockpile.—During 1975 the GSA inventory was reduced from 391,600 tons to 385,714 tons.

PRICES

Effective January 1, 1975, National Zinc lowered its quote on Prime Western zinc by 0.5 cent per pound to 39 cents per pound. Slack demand, falling free market prices, and mounting producer inventories put downward pressure on prices.

ASARCO raised its list price for Prime Western from 35 to 38.5 cents per pound and revamped its premium-grade pricing system. The company, which had been selling zinc at the Metals Week average price, began giving its customers the option of buying at the Metals Week average or the list price. New Jersey Zinc lowered its price for Prime Western to 39 cents per pound, f.o.b. Palmerton, Pa., freight allowed.

By March the price quoted by U.S. producers ranged from 38 to 39 cents per pound for Prime Western and 39.5 cents per pound for Special High Grade. Most quotes were on a delivered basis. The industry pattern was to adjust prices on various grades to make them more competitive with foreign producers.

In September, New Jersey Zinc announced a price increase of 2 cents per pound effective October 10. On October 30, the company withdrew the increase when other U.S. producers did not follow suit. The average U.S. price for zinc in 1975 was 38.96 cents per pound.

In January, European zinc producers began withdrawing zinc warrants from London Metal Exchange (LME) warehouses to support the price by reducing the supply of uncommitted metal rather than buying and selling on the LME. This action pushed LME prices to £354 per metric ton (37.8 cents per pound U.S. equivalent) for Good Ordinary Brand (GOB) zinc (Prime Western equivalent). The producer price was £360 per metric ton (38.6 cents per pound). By May LME prices dipped to £319 (33.6 cents per pound). Production cuts by the European producers failed to stem falling prices. In June prices touched £309 (32.5 cents per pound), but producers became active and pushed the price to £330 (34.1 cents per pound). By midyear the weakness of the pound sterling put pressure on the continental producers to raise prices. At the end of August cash quotes reached £360 (34.5 cents per pound), the same as the producer price.

On October 8, two producers raised prices to £390 (36.1 cents per pound), citing the decline in sterling value as the chief reason. As other producers followed, LME prices advanced from £337 per metric ton (31.2 cents per pound) to £345 (32.1 cents per pound) in late November. In December, Electrolytic Zinc of Australasia Ltd. precipitated the move to a dollar quote of $795 per metric ton (36.1 cents per pound) because of problems with currency alinements. By yearend the dollar quote was accepted by all major European zinc producers, in addition to Canadian and Australian producers.

In February, U.S. dealer prices for Special High Grade zinc were 34.5 to 36 cents per pound. Dealers quoted 35 to 35.5 cents per pound for Special High Grade in May, but business was slow. In late August quotes for Special High Grade climbed to 37.25 to 38 cents per pound as demand improved. By December U.S. dealer Special High Grade was down to 35 cents per pound compared with 39.5 cents per pound for producer metal.

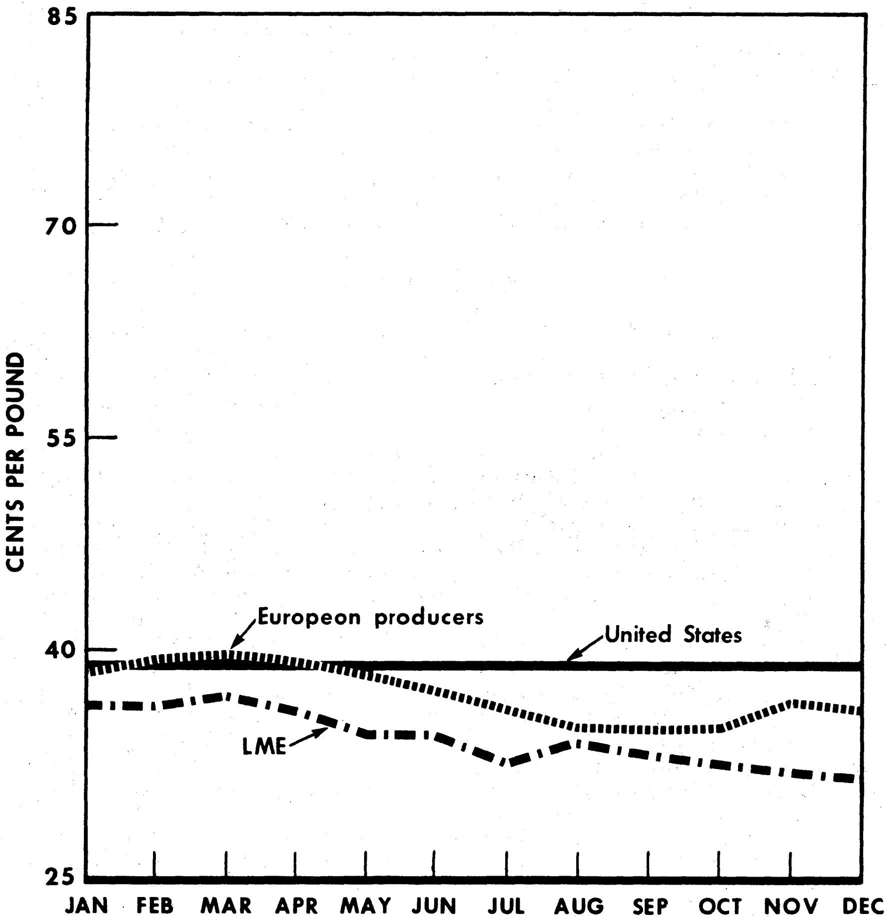

Figure 5.—Average monthly prices in 1975 for U.S. Prime Western zinc and equivalent foreign grade.

FOREIGN TRADE

Exports of unwrought zinc and alloys was 9,627 tons in 1975, a 75% decrease from that of 1974. The Netherlands received 43% of the exports; Brazil, 18%; and Venezuela, 14%. Wrought zinc and zinc alloy exports were 13,095 tons in 1975, of which 62% went to Belgium-Luxembourg and 24% to Canada.

General imports of zinc in ore were 144,987 tons in 1975, a decrease of 40% from that of 1974. Canada supplied 68% and Honduras increased its portion to 9%. General imports of zinc metal were 380,437 tons, a decrease of 29% from that of 1974. Canada supplied 48% of the total; Spain, 7%; and Australia, 6%. Other leading suppliers, in decreasing order, were Finland, Peru, Belgium-Luxembourg, West Germany, and Mexico. Since 1973, zinc metal from Angola, Italy, Liberia, the Netherlands, Spain, and the Republic of South Africa has entered the U.S. market in increasing amounts, whereas less zinc has been imported from Australia, Belgium-Luxembourg, Canada, France, Japan, Poland, the United Kingdom, and Zaire.

Imports of ore for consumption were 428,544 tons in 1975, an increase of 220% over that of 1974. With the removal of the tariff on ores and concentrates in early August, 329,934 tons of zinc in concentrates was withdrawn from bonded warehouses in the last 5 months of the year. Metal imports for consumption was 374,922 tons in 1975, 31% less than in 1974.

There were no changes in the basic tariff rates in 1975 for slab zinc at 0.7 cent per pound, and zinc dust at 0.3 cent per pound. The duty rate for unwrought alloys of zinc, which includes diecasting alloys, was 19% ad valorem. On August 9, the duty of 0.67 cent per pound on zinc ores, concentrates, zinc-bearing materials, and zinc scrap (including skimmings and drosses) was suspended until June 30, 1978, as provided by Public Law 94–89.

WORLD REVIEW

Preliminary data from the World Bureau of Metal Statistics[4] indicated that the world consumption of zinc fell 14% from that of 1974. Australia and Western Europe suffered declines in consumption of about 23%, but Africa and centrally planned economy (CPE) countries as a group showed almost no change. Bureau of Mines data showed world mine production down 2%, and slab zinc production down 8%, from 1974 levels. In mining, declines in tonnage mined were especially noted in Canada, Greenland, Iran, Mexico, Thailand, the United States, Zaire, and Zambia. Australia, the Republic of South Africa, and Japan increased production significantly, and the CPE countries gained slightly. Tonnage declines in smelter production were most prominent in Australia, Belgium, France, West Germany, Japan and the United States, but production in the Netherlands and the Republic of Korea increased as new smelters came onstream. Zinc metal production in CPE countries increased slightly from that of 1974.

Stocks in LME warehouses increased from 14,000 tons in January to almost 70,000 tons by yearend. Most of the increase occurred in the last 4 months of the year. Producer stocks worldwide doubled to about 820,000 tons during the year. European producers held about 270,000 tons, Japanese producers about 240,000 tons, and other countries the remainder.[5]

In 1975, the net trade in slab zinc between market economy countries, including Yugoslavia and CPE countries, was a surplus of about 77,000 tons.

Australia.—Zinc production from the Mount Isa mine in Queensland, operated by Mount Isa Mines Ltd., was 126,000 tons, up from 113,400 tons in 1974. Zinc metal reserves at the mine were 3.4 million tons. Development of the new Hilton lead-zinc-silver mine continued, where reserves were 41 million tons of ore grading 9.6% zinc and 7.7% lead. The company completed its 55-ton-per-day pilot plant at the McArthur River lead-zinc-silver deposit in the Northern Territory. The orebody contained proven reserves of 210 million tons of ore assaying 9.5% zinc.

Cobar Mines Pty. Ltd. produced 7,320 tons of zinc, based on an assay of 47.7% zinc for the concentrate, from the Cobar mine in New South Wales. At the West Coast mine in Tasmania, comprised of the Rosebery, Hercules, and Farrell mines, EZ Industries Ltd. produced 63,014 tons of zinc from ore grading 12.8% zinc. The company also treated zinc-rich tailings at the site. Reserves, expressed as zinc metal, were given as 1.1 million tons. Mining of the willemite (zinc silicate) ore deposit at Beltana, South Australia continued, with 10,206 tons being shipped to the Risdon smelter and 26,059 tons being exported. Exploration of the Elura prospect near Cobar indicated a resource of about 20 million tons of lead-zinc-silver ore grading about 8.4% zinc.

The mines of Australian Mining and Smelting Ltd. produced 226,000 tons of zinc contained in 434,000 tons of concentrate. Ore milled was 2,030,000 tons, a level higher than that of 1974 despite the shortage of experienced miners. The capacity of the flotation mill was increased and a new plant to treat mine dump residues was nearing completion.

EZ Industries Ltd. produced 167,673 tons of zinc metal and 7,321 tons of zinc dust from its Risdon smelter in the fiscal year ending June 30, 1975. Production cuts

[4] World Bureau of Metal Statistics (London). World Metal Statistics. V. 29, No. 5, May 1976, pp. 90–92, 94.

[5] International Lead and Zinc Study Group. Lead and Zinc Statistics, Monthly Bulletin. V. 16, No. 6, June 1976, p. 6.

led to a capacity utilization of 60% by yearend. Production at the Cockle Creek smelter of Sulfide Corporation Pty. Ltd., which operated at about 65% of capacity most of the year, was 45,000 tons. Pollution control equipment was installed at a cost of $2.4 million. The Broken Hill Associated Smelters Pty. Ltd. embarked on a $9 million pollution control program at its Port Pirie smelter which produced 31,000 tons of zinc in 1975.

Bolivia.—Corporación Minera de Bolivia (COMIBOL) produced about one-half of the total Bolivian zinc production from ore grading 10.3% zinc. COMIBOL reported measured and indicated recoverable reserves at yearend 1974 to be 1.5 million tons of ore grading 13.3% zinc and 1.3% lead. In addition, low-grade reserves contain another 19,000 tons of zinc and inferred reserves contain 94,000 tons of zinc.

ASARCO Incorporated, through a wholly-owned subsidiary, acquired a 58% interest in a new Bolivian corporation to operate the Quioma lead-zinc-silver mines. The new corporation will more than double annual capacity to 6,800 tons of zinc and 4,000 tons of lead in concentrates.

Dowa Mining Co. announced plans to explore for zinc in central Bolivia in a joint venture with COMIBOL. Australian Mining and Smelting Ltd. was also reported to be exploring for zinc.

Brazil.—Brazilian, Spanish, Belgian, and British interests formed a new company, Cia. Paraibuna de Metais, S.A., to build a 33,000-ton-per-year electrolytic refinery at Juiz de Fora. The expanded electrolytic smelter of Cia. Mineira de Metais, S.A., at 42,000 tons per year, was scheduled for completion in 1976.

Canada.—Mine output, at 1,193,809 tons, was 7% lower than that of 1974. Depleted reserves forced the closure of the Annex mine in British Columbia, and the Joutel and Normetal mines in Quebec. In August, the Daniel's Harbor mine, jointly owned by Tecam Ltd. (63.4%) and AMAX Zinc (Newfoundland) Ltd. (36.6%), was opened in Newfoundland. In Quebec, Société Minière Louvem started operations in January, and late in the year Lemoine Mines Ltd. brought its mine in the Chibougamau region into production.[6]

The leading producing provinces were Ontario with 31% of the total zinc production, followed by New Brunswick, 17%; Northwest Territories, 12%; and Quebec and the Yukon, 11% each. Data for the principal producing mines are given in table 2. Metal output was 470,600 tons, about 700 tons greater than that of 1974. Consumption of zinc was 110,000 tons, about 10% below that of 1974.

Texasgulf Inc. mined about 2.27 million tons of ore from the open pit and about 1.36 million tons from underground workings at the Kidd Creek mine in Timmins, Ontario. By the end of 1976, all mining will be underground as development progresses down to the 1,600-foot level. The program to increase mine capacity to 5 million tons of ore per year by the addition of the No. 2 underground mine and fourth concentrator circuit was on schedule. The drilling program to outline ore below the 2,800-foot level indicated ore to at least the 5,000-foot level. Mattabi Mines Ltd. exported about 95% of its production from the Mattabi mine north of Ignace. The Lyon Lake Division of Mattagami Lake Mines Ltd. completed installation of a mining facility, with production scheduled for late 1977. Ore reserves at the mine, located 5 miles from the Mattabi mine, were given at 4 million tons averaging 6.66% zinc with lesser quantities of copper, lead, silver, and gold.

In New Brunswick, Brunswick Mining & Smelting Corp. Ltd. continued its expansion of the No. 12 mine to increase capacity to 11,000 tons per day by 1979. The company experienced a total operating cost per ton of ore milled of $15.81,[7] compared with $12.89 in 1974 at its No. 12 underground mine, and $9.83 at the open pit mine, up from $8.41 in 1974. Texasgulf established more than 6 million tons of zinc-copper-lead mineralization at its Half Mile Lake project.

On Baffin Island in the Northwest Territories, Nanisivik Mines Ltd., in which Texasgulf has a 35% net profits interest, planned to begin production in late 1976 at the rate of about 130,000 tons of zinc concentrate per year. Another Texasgulf property, the Izok Lake sulfide deposit, contains 7 million tons of ore assaying 14.8% zinc which is suitable for open pit mining. Two other zones, the Hood River Nos. 10 and 41, contain an additional

[6] Barry, G. S. Canadian Mineral Survey 1975. Department of Energy, Mines, and Resources, Ottawa, Canada. February 1976, pp. 33–38.

[7] Where necessary values have been converted from Canadian dollars to U.S. dollars at the rate of CAN $1.017=US$1.00.

820,000 tons averaging 3.74% zinc. Pine Point Mines Ltd. found a new ore body of 600,000 tons grading 17% combined zinc-lead.

Mattagami Lake Mines, Ltd. shipped 85% of its zinc concentrate from the Mattagami mine in Quebec to the Valleyfield smelter in Quebec; 10% of the concentrate was exported, and 5% was stockpiled. Orchan Mines Ltd. ceased operations at Garon Lake at yearend because of depletion of the ore.

The new zinc mine near Daniel's Harbor, Newfoundland, operated by the Newfoundland Zinc Division of Tecam Ltd., was put into operation in July at a cost of almost $18 million. Several small ore bodies mined by open pit methods supplied the mill material until completion of the underground development. Tecam's 63.4% share of the concentrate is refined in Canada. Operating cost per ton of ore milled was $8.94.

In Manitoba, ore production by Hudson Bay Mining & Smelting Co., Ltd. was 100,657 tons less than that of 1974 because of labor shortages and development work in the Flin Flon-Snow Lake area. Development work continued on the Centennial and Westarm mines. Production costs at the underground Fox mine of Sherritt Gordon Mines Ltd. increased from $12.49 in 1974, to $14.69 per ton of ore milled, and from $8.58 in 1974, to $10.80 at the open pit Ruttan mine.

Texasgulf Canada Ltd. produced 93,000 tons of zinc metal at its smelter in Ontario, down from 107,900 tons in 1974. Cominco Ltd. produced 194,000 tons at Trail, B.C., up from 162,000 tons in 1974. A new 850-ton-per-day sulfuric acid plant began operation, replacing two older ones. Canadian Electrolytic Zinc Ltd. had almost completed a 50% expansion of its Valleyfield, Quebec smelter by yearend. The capacity increase to 225,000 tons per year will cost about $61 million. Production of metal in 1975 was 117,700 tons, compared with 134,800 tons in 1974. Hudson Bay Mining & Smelting Co., Ltd. produced 65,118 tons of zinc.

Canadian zinc reserves on January 1, 1975, were given as 31.2 million tons at the producing mines and deposits under development, and an additional 7.3 million tons in undeveloped deposits for which production is foreseen.[8] The Provinces of New Brunswick and Ontario contain about one-half of the reserves at producing properties, whereas the Yukon and Northwest Territories hold most of the reserves slated for future production.

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[8] Pages 18 and 19 of work cited in footnote 6.

Table 2.—Principal Canadian zinc producers in 1975

Company	Mine	Mill capacity, thousand tons per day	Recoverable metals	Ore milled, thousand tons	Zinc content: Ore, percent	Zinc content: Concentrate, tons	Zinc recovery factor, percent	Reserves: Ore, thousand tons	Reserves: Zinc, percent
British Columbia:									
Cominco Ltd	Sullivan	8,000	Zinc, lead	[1] 2,208	4.2	83,080	--	59,000	[2] 10.9
Do	H. B	1,200	do	453	3.4	13,999	--		
Reeves MacDonald Mines, Ltd	Annex	1,000	do	36	3.1	937	--	Depleted	--
Western Mines Ltd	Lynx and Myra	1,100	Zinc, lead, copper, silver.	287	7.6	19,942	--	1,700	7.9
Kam-Kotia Burkam Joint Venture.	Silmonac	120	Zinc, lead, silver.	12	4.8	519	--	10	NA
Manitoba:									
Hudson Bay Mining & Smelting Co., Ltd.	Flin Flon-Snow Lake area.	8,500	Zinc, lead, gold, silver, copper.	1,470	3.0	26,553	--	[3] 17,500	2.8
Sherritt Gordon Mines, Ltd	Fox	3,000	Zinc, copper	1,007	1.8	10,875	60	[3] 8,700	2.1
Do	Ruttan	10,000	do	3,341	1.9	49,104	--	43,600	1.5
New Brunswick:									
Brunswick Mining & Smelting Corp., Ltd.	Bathurst	10,000	Zinc, lead, silver, copper.	3,427	7.1	184,100	75.1	100,800	9.2
Heath Steele Mines Ltd	Newcastle	3,100	do	1,089	4.0	33,219	--	35,200	4.4
Nigadoo River Mines Ltd	Robertville	1,000	do	255	2.7	5,592	--	NA	NA
Newfoundland:									
ASARCO Incorporated	Buchans	1,250	Zinc, lead, silver.	232	10.5	22,600	92.6	NA	NA
Tecam Ltd.[4]	Daniel's Harbor	1,500	Zinc	243	6.3	15,638	--	4,500	8.8
Ontario:									
Texasgulf Canada Ltd	Kidd Creek	10,000	Zinc, lead, silver, copper.	3,630	8.2	262,444	--	86,000	5.9
Selco Mining Corp. Ltd	South Bay	500	Zinc, copper	168	11.2	17,205	--	NA	NA
Sturgeon Lake Mines Ltd	Sturgeon Lake	1,200	Zinc, lead, copper, silver.	377	9.1	24,753	--	1,804	10.3
Mattabi Mines Ltd	Mattabi	3,000	do	1,075	7.3	68,700	87	9,900	6.7
Noranda Mines Ltd	Geco Division	5,000	do	1,599	3.5	44,500	--	28,100	3.6
Willroy Mines Ltd	Kirkland Lake	1,400	do	327	3.8	11,007	--	583	3.9
Quebec:									
Falconbridge Copper Ltd	Lake Dufault	1,500	Zinc, copper	560	3.4	14,994	--	1,859	4.6
Joutel Copper Mines Ltd	Joutel[5]	700	Zinc, copper	88	6.1	3,975	--	Depleted	--
Kerr-Addison Mines Ltd	Normetal[6]	1,000	Zinc, copper, silver, gold.	82	5.9	3,900	--	Depleted	--
Manitou-Barvue Mines Ltd	Manitou	1,600	Zinc, lead, silver.	245	1.8	3,045	--	911	[7] 2.3
Mattagami Lake Mines Ltd	Matagami	3,850	Zinc, copper, silver, gold.	1,286	7.3	86,100	92.4	10,831	8.4
Orchan Mines Ltd	Garon Lake	1,900	Zinc, copper, silver.	422	4.7	16,500	--	3,222	6.9
Sullivan Mining Group Ltd	Stratford Centre.[8]	1,400	Zinc, copper	324	2.7	6,220	--	1,050	1.7
Societe Miniere Louvem	Louvem	([9])	do	150	NA	15,359	--	2,000	8.0
Lemoine Mines Ltd	Lemoine	400	do	7	10.1	[10] 532	--	625	10.8

See footnotes at end of table.

Table 2. Principal Canadian zinc producers in 1975—Continued

Company	Mine	Mill capacity, thousand tons per day	Recoverable metals	Ore milled, thousand tons	Zinc content		Zinc recovery factor, percent	Reserves	
					Ore, percent	Concentrate, tons		Ore, thousand tons	Zinc, percent
Northwest Territories:									
Pine Point Mines Ltd	Pine Point	10,000	Zinc, lead	3,905	4.9	177,694	--	99,200	5.4
Yukon Territory:									
Cyprus Anvil Mining Corp	Faro	10,000	do	3,225	5.4	147,127	--	NA	NA
United Keno Hill Mines Ltd	Elsa, Husky, No Cash.	500	Zinc, lead, silver.	91	1.2	316	--	208	NA

NA Not available.
[1] Ore produced.
[2] Combined and zinc content.
[3] Recoverable.
[4] Six months operation to December 31, 1975.
[5] Mine closed June 30, 1975.
[6] Mine closed April 29, 1975.
[7] After dilution.
[8] Milled mine output from Cupra, D'Estrie, and Clinton mines in fiscal year ending August 31, 1975.
[9] Ore milled on toll by Manitou-Barvue Mines Ltd.
[10] Development ore from operations beginning in November.

Source: Company Annual Reports and Department of Energy, Mines and Resources, Ottawa, Canada.

Denmark.—The Black Angel mine in Greenland, owned by Greenex A/S, produced 168,000 tons of zinc concentrate from 651,000 tons of mined ore. A mile-long tunnel connecting the Angel and Cover zones was completed, which resulted in the delineation of over 1.2 million tons of ore assaying 14.1% zinc, 4% lead, and 1 ounce of silver per ton.

France.—Cie. Royale Asturienne des Mines produced 57,000 tons of zinc metal at its Auby plant, compared with 91,000 tons in 1974, because of the changeover from vertical retorts to the new 110,000-ton-per-year electrolytic refinery. Most of the feed material was supplied by Canada and Sweden. The company entered the U.S. market in 1975 through the creation of a sales corporation, Asturmet, Inc.

Honduras.—Production from the El Mochito mine of Rosario Resources Corp. was 346,352 tons grading 8.69% zinc, 7.82% lead, 10.98 ounces of silver per ton, and minor quantities of gold. Zinc in concentrate was 24,321 tons. Reserves increased by over 527,000 tons to 6.3 million tons averaging 8.07% zinc and 4.78% lead.

India.—A new 33,000-ton-per-year electrolytic smelter was under construction by Hindustan Zinc, Ltd. at Visakhapatnam. The capacity of the smelter at Debari was being increased to 50,000 tons per year from its current capacity of 20,000 tons. Both smelters should be operational in 1976. Production of zinc metal by Cominco Binani Zinc Ltd. was reduced to 9,900 tons in 1974 because of delayed shipments of concentrate.

Ireland.—The principal uncertainties in connection with the Navan lead-zinc mine were resolved in September when the Irish Government and Tara Mines Ltd. formally executed a mining lease, thereby allowing resumption of construction activity. The equity of Tara Mines would be owned 75% by Tara Exploration and Development Co. Ltd., and 25% by the Irish Ministry for Industry and Commerce, which would also collect royalty payments of 4.5% of pretax income. The mine was expected to provide about 2.5 million tons of ore per year to the 7,500-ton-per-day concentrator during the 25-year lease. About 500,000 tons of lead and zinc concentrates will be transported by rail to the shipping facility at Dublin. Tara expected recoveries for zinc and lead of 90% and 82%, respectively, from ore assaying 11% zinc and 2.4% lead. About 800 people will be employed in the mining operation.

During the year, Northgate Exploration Ltd. treated 648,477 tons of ore from the Tynagh mine, County Galway. The ore grade was 4.27% zinc compared with 4.38% in 1974. Metallurgical recovery of zinc was 80.4%, up from 77.8% in 1974. Payable metal in concentrate was 17,350 tons. Direct operating costs per ton of ore mined during 1975 were $13.55, up from $10.51 in 1974. Ore reserves were given at 2.4 million tons assaying 3.55% lead, 3.61% zinc, 0.21% copper, and 1.16 ounces of silver per ton. At the Tatestown zinc-lead prospect in the Navan area, Northgate indicated the possibility of a deposit containing 6.7% combined zinc and lead.

Bula Ltd., 49% owned by the Irish Government, reported ore reserves at Navan of 21.6 million tons grading 8% combined lead and zinc. Bula stated that a mining plan for the Navan deposit will necessitate diversion of the Blackwater River or a substantial safety pillar as a barrier between the river and the workings.

Mogul of Ireland Ltd. mined 987,984 tons of ore, about 15% of which came from pillar recovery areas. The milled tonnage was 1,012,686 tons grading 6.01% zinc and 2.67% lead. Operating costs increased 16% over those of 1974, with energy costs increasing 50%. Ore reserves after dilution were 5.9 million tons grading 6.36% zinc and 2.53% lead

Japan.—Japanese zinc metal producers operated at about 70% of capacity in 1975, turning out 773,600 tons of metal compared with 936,850 tons in 1974. Zinc exports declined 54% from that of 1974, mainly because of sharply lower shipments to the United States. Imports of zinc concentrates declined by 25% in 1975 as Japanese producers prevailed upon Australian and Peruvian suppliers to curtail shipments. At yearend negotiations were underway with Cyprus Anvil Mining Corp. of Canada to reduce concentrate shipments by 30%.

In October, Hachinohoe Smelting Co. increased its smelting charge by $27 per ton to about $180 per ton for zinc metal, and Akita Zinc Co. Ltd. increased its charge to about $205 per ton to be in effect until March 1976, in an effort to offset higher costs of energy and pollution abatement. Mitsui Mining & Smelting Co.

Ltd. closed its smelter in Kamioka for a month but increased production proportionately at its two other smelters in an economy move.

Mexico.—Industrial Minera Mexico, S.A. completed expansion of its Taxco silver-lead-zinc mine, including doubling the capacity at the old concentrator. The company negotiated a $150 million loan, most of which will be used to construct a 125,000-ton-per-year electrolytic refinery at San Luis Potosí. Detailed engineering of the plant was underway. Other projects included expansion of existing mines and the reopening of old mines. The lead-zinc mine at Parral was closed due to depletion of reserves, although the mill continued custom operation for other local mines.

Cía. Fresnillo, S.A. brought its 8,000-ton-per-year zinc-lead mine at Zimapan onstream in 1975. The company stated its reserves as 5.8 million tons grading 3.9% zinc, 3.6% lead, 0.39% copper, and 4.26 ounces of silver per ton of ore. Texasgulf Inc. extended its reserves at the Rio Murga property to 9 million tons grading about 1% zinc, Explomin, S.A., a company formed by Comisión de Fomento Minero (33%), Placer Development Co. (34%), and a Mexican group, Bancomer (33%), was considering the development of the Real de Angeles property in Zacatecas. Reserves of 45 million tons of ore grading 1% zinc and 0.9% lead were identified.

The production of refined zinc by Industria Peñoles, S.A. at its Torreon electrolytic plant increased to 75,498 tons, 32% over that of 1974.

Nicaragua.—Neptune Mining Co., 51.8% owned by ASARCO, treated 181,138 tons of ore averaging 7.2% zinc and 1% lead. Reserves in the Vesubio, Pioneer, and Venus mines were estimated at 1.2 million tons grading 9.78% zinc and 1.23% lead, with lesser amounts of copper, silver, and gold.

Peru.—Belgium and West Germany granted loans to Minero Perú to help finance the new Cajamarquilla zinc smelter scheduled for startup in 1978. Centromin, the former Cerro de Pasco operation, was planning to increase capacity of its La Oroya smelter to 143,000 tons of zinc per year by 1980. The first part of the expansion program currently under way will increase capacity to 100,000 tons per year in 1976.

Cía. Minerales Santander, Inc. a subsidiary of St. Joe Minerals Corp., produced 49,103 tons of zinc concentrate for export, down from 67,478 tons in 1974, because of unsettled labor conditions. Cía. de Minas Buenaventura S.A. began production from a new 200-ton-per-day mill at Colquicocha, Cajatambo Province, that should produce about 1,500 tons of zinc metal per year. Cía. Minera San Ignacia de Morococha S.A. began expansion of its plant facilities at the San Vicente mine to 50,000 tons of zinc per year from the current level of about 33,000 tons.

Cía. Minera del Madrigal, a division of Homestake Mining Co., milled 259,724 tons of copper-lead-zinc ore grading 5% zinc to produce 17,885 tons of zinc concentrate. The capacity of the plant was being increased from 770 tons to about 1,100 tons per day. ASARCO, through Northern Peru Mining Corp., produced 4,400 tons of zinc from the Quiruvilca mine.

South Africa, Republic of.—Phelps Dodge Corp. pinpointed three orebodies at Aggenys in northern Cape Province and has begun developing the Broken Hill deposit. Total reserves at two locations were given as 2.3 million tons of zinc, 5.7 million tons of lead, 900,000 tons of copper, and 200 million ounces of silver. Much of the ore is amenable to open pit mining. The metal content of the third area was estimated to be 1.9 million tons of zinc, 800,000 tons of lead, and 33 million ounces of silver.

Newmont Mining Corp. and O'Okiep Copper Co. continued metallurgical testing and underground work on the Gamsburg zinc deposit in Cape Province. Ore reserves were estimated at 94 million tons averaging 7.4% zinc and 0.55% lead before dilution. A 50-ton-per-day pilot plant was built to treat the ore. It was reported that the presence of about 3% manganese in the concentrates constitutes a potential problem in electrolytic refining.

South West Africa.—At the Tsumeb mine, Tsumeb Corp. Ltd. mined and milled 466,827 tons of ore grading 2.47% zinc, 9.73% lead, and 4.27% copper, slightly lower than production in 1974. The zinc mill recovery rate was 16.6%, yielding 3,729 tons of zinc concentrate averaging 51.3% zinc and 0.94% cadmium. Ore reserves at the mine at yearend were estimated at 5.6 million tons containing 7.75% lead, 4.56% copper, and 2.06% zinc.

Spain.—Cominco Europe N/V reported

that the Rubiales mine was expected to start up in the last quarter of 1976. Ore reserves were 11 million tons containing 1.3 million tons of combined lead and zinc.

Development of the d'Aznacollar mine at Seville by d'Aznacollar d'Andaluza de Piritas, S.A. proceeded toward a 1978 opening. Reserves at the open pit mine were evaluated at 48 million tons grading 3.33% zinc, 1.74% lead, and lesser quantities of copper and silver. The expected production rate is 53,000 tons of zinc per year.

Capacity at the San Juan de Nieva electrolytic smelter was increased to 130,000 tons per year.

Thailand.—Thai Zinc Co. Ltd., began construction of its 66,000-ton-per-year smelter to process the silicate-carbonate zinc ore being mined at Mae Sot. About half of the smelter output will supply Thailand's annual demand; the remainder will be exported. Since three Japanese zinc producers who were prospective partners in the project declined to participate, The New Jersey Zinc Co., owner of Thai Zinc, was looking for an equity participant in the venture. The Thai Government will receive the standard royalty of 2.5% of the value of the metal, as well as a special royalty of $5.44 per ton. Total reserves at the mine were estimated at 3.9 million tons grading 25% zinc.

United Kingdom.—Production of slab zinc was 70,636 tons, 24% below that of 1974. In November, the smelter at Avonmouth was closed for maintenance, but a labor dispute arose which kept the smelter closed for the remainder of the year.

Yugoslavia.—Ore reserves at the Veliki Majdan zinc-lead mine in Serbia were considerably increased. Mine production could double in the next several years to 120,000 tons of ore per year.

TECHNOLOGY

At the Bureau of Mines Salt Lake City (Utah) Metallurgy Research Center work continued on the recovery of zinc from the nonferrous fraction of automobile scrap. Investigations of techniques for recovering zinc from zinc-base wastes as an alternate to pyrometallurgical methods were pursued at the College Park (Md.) Metallurgy Research Center. At the Rolla (Mo.) Metallurgy Research Center work progressed on methods of recovering zinc with minimal pollution, development of improved lead dioxide anodes and pure zinc cathodes for the electrolytic process, and the utilization of zinc concentrates containing excessive quantities of deleterious metals, including copper and nickel. A pilot plant for the aqueous chlorine leaching of 500 pounds per day of lead-zinc concentrates and recovery of metal values was being constructed at the Reno (Nev.) Metallurgy Research Center. Another project involved the electrowinning of zinc from fused salts.

Results of several research investigations were published by the Bureau of Mines.[9]

A review of recent improvements in leaching techniques in the electrolytic zinc process was published,[10] as were reports on combined zinc-lead smelting and energy consumption.[11] For the industry, the weighted average of energy consumption per ton of zinc produced was 65 x 10^6 Btu.

A comprehensive coverage of zinc-related investigations and an extensive review of current world literature on the uses of zinc and its products are contained in bimonthly issues of the 1975 Zinc Abstracts published by the Zinc Institute, Inc., New York, and provided free of charge.

Progress reports of the projects supported by the International Lead Zinc Research Organization, Inc. are released annually in the ILZRO Research Digest.

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[9] Froisland, L. J., K. C. Dean, L. Peterson, and E. G. Valdes. Recovering Metal From Nonmagnetic Auto-Shredder Reject. BuMines RI 8049, 1975, 18 pp.

Landsberg, A., A. Adams, and J. L. Schaller. Chlorination Kinetics of Selected Metal Sulfides. BuMines RI 8002, 1975, 15 pp.

Scheiner, B. J., K. P. V. Lei, and R. E. Lindstrom. Lead-Zinc Extraction From Concentrates by Electrolytic Oxidation. BuMines RI 8092, 1975, 13 pp.

Valdez, E. G., and K. C. Dean. Experiments in Treating Zinc-Lead Dusts From Iron Foundries. BuMines RI 8000, 1975, 13 pp.

[10] Gordon, A. R., and R. W. Pickering. Improved Leaching Technologies in the Electrolytic Zinc Industry. Met. Trans., v. 6B, No. 1, 1975, pp. 43-53.

[11] Binetti, G., J. Koteski, and D. Temple. Combined Zinc-Lead Smelting: Recent Practice and Developments. J. Metals, v. 27, No. 9, September 1975, pp. 4-11.

Battelle Columbus Laboratories. Energy Use Patterns in Metallurgical and Nonmetallic Mineral Processing (Phase 4-Energy Data and Flowsheets, High-Priority Commodities). BuMines OFR 80-75, June 1975, 192 pp; available from the National Technical Information Service, Springfield, Va. 22161, PB 245 759/AS.

Table 3.—Mine production of recoverable zinc in the United States, by State

(Short tons)

State	1971	1972	1973	1974	1975
Arizona	7,761	10,111	8,427	9,699	8,655
California	3,003	1,202	20	8	206
Colorado	61,181	63,801	58,339	49,489	48,460
Idaho	45,078	38,647	46,107	39,469	40,926
Illinois	12,706	11,378	5,250	4,104	W
Kentucky	5,268	1,780	273	--	41
Maine	5,850	5,820	19,640	10,425	8,318
Missouri	48,215	61,923	82,350	91,987	74,867
Montana	361	12	73	136	110
Nevada	71	--	--	3,405	5,496
New Jersey	29,977	38,096	33,027	32,848	31,105
New Mexico	13,959	12,735	12,327	13,784	11,015
New York	63,420	60,749	81,455	93,077	76,612
Pennsylvania	27,438	18,344	18,857	20,288	21,090
Tennessee	119,295	101,722	64,172	85,671	83,293
Utah	25,701	21,853	16,800	12,619	19,640
Virginia	16,829	16,789	16,683	17,195	15,151
Washington	5,782	6,483	6,378	6,909	W
Wisconsin	10,645	6,873	8,672	8,737	W
Other States	3	--	--	23	24,370
Total	502,543	478,318	478,850	[1]499,872	469,355

W Withheld to avoid disclosing individual company confidential data, included with "Other States."

[1] Data do not add to total shown because of independent rounding.

Table 4.—Mine production of recoverable zinc in the United States, by month

(Short tons)

Month	1974	1975	Month	1974	1975
January	43,051	42,103	August	41,499	39,141
February	39,597	39,129	September	39,968	37,427
March	42,236	41,562	October	43,751	39,623
April	40,638	40,304	November	41,832	36,355
May	41,162	40,260	December	41,589	37,068
June	42,915	39,492			
July	41,635	36,891	Total	[1]499,872	469,355

[1] Data do not add to total shown because of independent rounding.

Table 5.—Production of zinc and lead in the United States in 1975, by State and class of ore, from old tailings, etc., in terms of recoverable metals

(Short tons)

State	Zinc ore			Lead ore			Zinc-lead ore		
	Gross weight (dry basis)	Zinc content	Lead content	Gross weight (dry basis)	Zinc content	Lead content	Gross weight (dry basis)	Zinc content	Lead content
Arizona	--	--	--	535	--	42	2,595	267	146
California	2,160	197	42	--	--	--	--	--	--
Colorado	177,494	13,118	1,690	900	--	33	564,911	23,692	15,776
Idaho	(1)	(1)	(1)	188,319	1,846	18,370	1,073,643	37,085	30,912
Kentucky	--	--	--	--	--	--	--	--	--
Maine	--	--	--	--	--	--	--	--	--
Missouri	--	--	--	8,467,794	74,867	515,958	--	--	--
Montana	--	--	--	209	1	20	81	5	5
Nevada	800	14	5	250	1	5	390,170	5,428	2,604
New Jersey	191,220	31,105	--	--	--	--	--	--	--
New Mexico	(1)	(1)	(1)	--	--	--	--	--	--
New York	1,246,733	76,612	3,027	--	--	--	--	--	--
Pennsylvania	471,342	21,090	--	--	--	--	--	--	--
Tennessee	3,105,719	78,633	--	--	--	--	--	--	--
Utah	--	--	--	964	16	101	289,754	19,624	12,578
Virginia	620,121	15,151	2,551	--	--	--	--	--	--
Other States [2]	421,047	9,210	885	25	--	--	306,534	10,131	1,849
Total	6,236,636	245,130	8,200	8,658,996	76,731	534,529	2,627,688	96,232	63,870
Percent of total zinc-lead	--	52	1	--	16	86	--	21	10

See footnotes at end of table.

Table 5.—Production of zinc and lead in the United States in 1975, by State and class of ore, from old tailings, etc., in terms of recoverable metals—Continued

(Short tons)

State	Copper-zinc, copper-lead and copper-zinc-lead ores			All other sources [3]			Total		
	Gross weight (dry basis)	Zinc content	Lead content	Gross weight (dry basis)	Zinc content	Lead content	Gross weight (dry basis)	Zinc content	Lead content
Arizona	94,608	8,366	--	39,260,759	22	232	39,358,497	8,655	420
California	--	--	--	23,639	9	24	25,799	206	66
Colorado	408,800	10,825	7,704	134,904	825	1,885	1,287,009	48,460	27,088
Idaho	--	--	--	[1] 548,233	[1] 1,995	[1] 1,113	1,810,195	40,926	50,395
Kentucky	--	--	--	--	41	W	--	41	W
Maine	211,211	8,318	364	--	--	--	211,211	8,318	364
Missouri	--	--	--	--	--	--	8,467,794	74,867	515,958
Montana	--	--	--	21,153	104	180	21,443	110	205
Nevada	13,000	49	355	1,491	4	7	405,711	5,496	2,976
New Jersey	--	--	--	--	--	--	191,220	31,105	--
New Mexico	--	--	--	[1] 1,778,742	[1] 11,015	[1] 1,931	1,778,742	11,015	1,931
New York	--	--	--	--	--	--	1,246,733	76,612	3,027
Pennsylvania	--	--	--	--	--	--	471,342	21,090	--
Tennessee	1,634,845	4,660	--	--	--	--	4,740,564	83,293	--
Utah	--	--	--	--	--	--	290,718	19,640	12,679
Virginia	--	--	--	--	--	--	620,121	15,151	2,551
Other States [2]	--	--	--	65,987	5,029	1,070	793,593	24,370	3,804
Total	2,362,464	32,218	8,423	41,834,908	19,044	6,442	61,720,692	469,355	621,464
Percent of total zinc-lead	--	7	2	--	4	1	--	100	100

W Withheld to avoid disclosing individual company confidential data.
[1] Zinc ore and ore from "other sources" combined to avoid disclosing individual company confidential data.
[2] Other States includes Illinois, Oregon, Washington, and Wisconsin.
[3] Lead and zinc recovered from copper, gold, silver, and fluorspar ores, and from mill tailings and miscellaneous cleanups.

Table 6.—Twenty-five leading zinc-producing mines in the United States in 1975 in order of output

Rank	Mine	County and State	Operator	Source of zinc
1	Balmat	St. Lawrence, N.Y	St. Joe Minerals Corp	Zinc ore.
2	Buick	Iron, Mo	AMAX Lead Co. of Missouri	Lead ore.
3	Sterling	Sussex, N.J	New Jersey Zinc Co	Zinc ore.
4	Bunker Hill	Shoshone, Idaho	The Bunker Hill Co	Lead-zinc ore.
5	Friedensville	Lehigh, Pa	New Jersey Zinc Co	Zinc ore.
6	Zinc Mine Works	Jefferson, Tenn	United States Steel Corp	Do.
7	Young	do	ASARCO Incorporated	Do.
8	New Market	do	do	Do.
9	Austinville and Ivanhoe	Wythe, Va	New Jersey Zinc Co	Do.
10	Star Unit	Shoshone, Idaho	The Bunker Hill Co. and Hecla Mining Co.	Lead-zinc ore.
11	Eagle	Eagle, Colo	New Jersey Zinc Co	Zinc ore.
12	Burgin	Utah, Utah	Kennecott Copper Corp	Lead-zinc ore.
13	Immel	Knox, Tenn	ASARCO Incorporated	Zinc ore.
14	Leadville	Lake, Colo	do	Lead-zinc ore.
15	Ground Hog	Grant, N. Mex	do	Do.
16	Pend Oreille	Pend Oreille, Wash	The Bunker Hill Co	Do.
17	Idarado	Ouray, and San Miguel, Colo.	Idarado Mining Co	Copper-lead-zinc ore.
18	Magmont	Iron, Mo	Cominco American Inc	Lead ore.
19	Bruce	Yavapai, Ariz	Cyprus Mines Corp	Copper-zinc ore.
20	Blue Hill	Hancock, Maine	Kerramerican Inc	Zinc ore.
21	Edwards	St. Lawrence, N.Y	St. Joe Minerals Corp	Do.
22	Elmwood	Smith, Tenn	New Jersey Zinc Co	Do.
23	Jefferson City	Jefferson, Tenn	do	Do.
24	Ontario	Summit, Utah	Park City Ventures	Lead-zinc ore.
25	Brushy Creek	Reynolds, Mo	St. Joe Minerals Corp	Lead ore.

Table 7.—Primary and redistilled secondary slab zinc produced in the United States [1]

(Short tons)

	1971	1972	1973	1974	1975
Primary:					
From domestic ores	403,750	400,969	399,119	346,993	307,959
From foreign ores	362,683	232,211	184,360	208,195	130,092
Total	766,433	633,180	583,479	555,188	438,051
Redistilled secondary	80,923	73,718	83,187	78,535	57,886
Total (excludes zinc recovered by remelting)	847,356	706,898	666,666	633,723	495,937

[1] Excludes processed GSA zinc.

Table 8.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, by method of reduction

(Short tons)

Method of reduction	1971	1972	1973	1974	1975
Electrolytic primary	321,517	259,816	211,921	227,430	232,059
Distilled	444,916	373,364	371,558	327,758	205,992
Redistilled secondary:					
At primary smelters	68,612	63,034	67,758	56,342	34,931
At secondary smelters	12,311	10,684	15,429	22,193	22,955
Total	847,356	706,898	666,666	633,723	495,937

Table 9.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, by grade
(Short tons)

Grade	1971	1972	1973	1974	1975
Special High	367,609	310,074	275,665	277,024	242,128
High	73,314	44,782	25,900	16,912	18,913
Intermediate	58,240	43,358	38,239	22,818	13,104
Brass Special	71,100	76,954	60,034	9,694	5,629
Prime Western	277,093	231,735	266,828	307,275	216,163
Total	847,356	706,898	666,666	633,723	495,937

Table 10.—Primary slab zinc produced in the United States, by State where smelted
(Short tons)

State	1971	1972	1973	1974	1975
Idaho	94,012	101,743	98,321	92,321	92,300
Illinois	46,389	--	26,616	55,527	55,337
Montana	115,480	69,754	--	--	--
Oklahoma	126,908	114,162	77,819	43,187	35,071
Pennsylvania [1]	228,651	210,860	250,752	240,891	152,280
Texas	154,993	136,661	129,971	123,262	103,063
Total	766,433	633,180	583,479	555,188	438,051

[1] Prior to 1972, included West Virginia.

Table 11.—Annual slab zinc capacity of primary zinc plants in the United States in 1975

Type of plant	Plant location	Slab zinc capacity (short tons)
Electrolytic plants:		
Amax Zinc Co., Inc	Sauget, Ill	84,000
ASARCO, Incorporated	Corpus Christi, Tex	100,000
The Bunker Hill Co	Kellogg, Idaho	104,000
Horizontal-retort plants:		
ASARCO, Incorporated [1]	Amarillo, Tex	53,000
National Zinc Co	Bartlesville, Okla	56,000
Vertical-retort plants:		
New Jersey Zinc Co	Palmerton, Pa	118,000
St. Joe Minerals Corp	Monaca, Pa	190,000

[1] Plant closed May 1975.

Table 12.—Secondary slab zinc plants, by group capacity, in the United States in 1975

Company	Plant location	Slab zinc capacity (short tons)
Alger Pattern Works Inc	Indianapolis, Ind	48,500
Arco Die Cast & Metals Inc	Detroit, Mich	
Belmont Smelting & Refining Works	Brooklyn, N.Y	
W. J. Bullock, Inc	Fairfield, Ala	
Gulf Reduction Co	Houston, Tex	
Hugo Neu-Proler Co	Terminal Island, Calif	
Illinois Smelting & Refining Co	Chicago, Ill	
New England Smelting Works Inc	West Springfield, Mass	
Pacific Smelting Co	Torrance, Calif	
Peerless Alloy Inc	Denver, Colo	
Proler International Corp	Houston, Tex	
Prolerized Schiabo Neu Co	Jersey City, N.J	
S-G Metals Industries, Inc	Kansas City, Kans	

Table 13.—Stocks and consumption of new and old zinc scrap in the United States in 1975

(Short tons, zinc content)

Class of consumer and type of scrap	Stocks Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks Dec. 31
Smelters and distillers:						
New clippings	252	1,001	1,199	--	1,199	54
Old zinc	288	5,795	--	5,460	5,460	623
Remelt zinc	7	1,317	1,324	--	1,324	--
Engravers' plates	174	1,172	--	1,116	1,116	230
Rod and die scrap	1,149	3,627	--	3,726	3,726	1,050
Diecastings	1,365	24,673	--	25,070	25,070	968
Fragmentized diecastings	2,599	13,678	--	14,866	14,866	1,411
Remelt die-cast slab	507	7,713	--	7,216	7,216	1,004
Skimmings and ashes	8,696	37,959	35,551	--	35,551	11,104
Sal skimmings	56	131	--	--	--	187
Die-cast skimmings	2,279	2,282	2,961	--	2,961	1,600
Galvanizers' dross	13,180	48,734	40,776	--	40,776	21,138
Flue dust	300	3,034	3,132	--	3,132	202
Chemical residues	--	2,145	2,145	--	2,145	--
Other	--	127	112	--	112	15
Total	30,852	153,388	87,200	57,454	144,654	39,586
Chemical plant, foundries, and other manufacturers:						
New clippings	1	4	4	--	4	1
Old zinc	9	24	--	18	18	15
Rod and die scrap	13	23	--	26	26	10
Diecastings	4	63	--	61	61	6
Skimmings and ashes	3,867	6,665	7,142	--	7,142	3,390
Sal skimmings	1,665	6,148	5,404	--	5,404	2,409
Die-cast skimmings	--	20	20	--	20	--
Flue dust	187	2,178	2,237	--	2,237	128
Chemical residues	1,243	10,521	6,940	--	6,940	4,824
Total	6,989	25,646	21,747	105	21,852	10,783
All classes of consumers:						
New clippings	253	1,005	1,203	--	1,203	55
Old zinc	297	5,819	--	5,478	5,478	638
Remelt zinc	7	1,317	1,324	--	1,324	--
Engravers' plates	174	1,172	--	1,116	1,116	230
Rod and die scrap	1,162	3,650	--	3,752	3,752	1,060
Diecastings	1,369	24,736	--	25,131	25,131	974
Fragmentized diecastings	2,599	13,678	--	14,866	14,866	1,411
Remelt die-cast slab	507	7,713	--	7,216	7,216	1,004
Skimmings and ashes	12,563	44,624	42,693	--	42,693	14,494
Sal skimmings	1,721	6,279	5,404	--	5,404	2,596
Die-cast skimmings	2,279	2,302	2,981	--	2,981	1,600
Galvanizers' dross	13,180	48,734	40,776	--	40,776	21,138
Flue dust	487	5,212	5,369	--	5,369	330
Chemical residues	1,243	12,666	9,085	--	9,085	4,824
Other	--	127	112	--	112	15
Total	37,841	179,034	108,947	57,559	166,506	50,369

Table 14.—Production of zinc products from zinc-base scrap in the United States

(Short tons)

Products	1971	1972	1973	1974	1975
Redistilled slab zinc	80,923	73,718	83,187	78,535	57,886
Zinc dust	29,095	40,569	36,531	29,339	35,479
Remelt zinc	1,590	5,850	1,096	893	127
Remelt die-cast slab	18,339	13,555	12,595	12,358	4,829
Zinc-die and diecasting alloys	3,316	3,927	4,786	4,393	4,740
Galvanizing stocks	633	872	670	872	1,435
Secondary zinc in chemical products	45,312	50,047	56,591	56,275	31,972

Table 15.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

Kind of scrap	1974	1975
New scrap:		
Zinc-base	122,232	108,813
Copper-base	136,791	97,476
Aluminum-base	3,750	--
Magnesium-base	300	173
Total	263,073	206,462
Old scrap:		
Zinc-base	45,722	56,605
Copper-base	25,733	19,686
Aluminum-base	3,854	240
Magnesium-base	100	208
Total	75,409	76,739
Grand total	338,482	283,201

Form of recovery	1974	1975
As metal:		
By distillation:		
Slab zinc [1]	78,535	57,886
Zinc dust	29,075	35,479
By remelting	1,743	1,562
Total	109,353	94,927
In zinc-base alloys	15,779	9,569
In brass and bronze	148,751	145,009
In aluminum-base alloys	7,879	337
In magnesium-base alloys	445	393
In chemical products:		
Zinc oxide (lead free)	32,104	19,329
Zinc sulfate	9,838	4,373
Zinc chloride	11,035	8,898
Miscellaneous	3,298	366
Total	229,129	188,274
Grand total	338,482	283,201

[1] Includes zinc content of redistilled slab made from remelt die-cast slab.

Table 16.—Zinc dust produced in the United States

Year	Quantity (short tons)	Value: Total (thousands)	Value: Average per pound
1971	50,259	$19,691	$0.196
1972	59,358	24,669	.208
1973	56,154	29,279	.261
1974	50,775	46,398	.457
1975	40,875	39,077	.478

Table 17.—Consumption of zinc in the United States

(Short tons)

	1971	1972	1973	1974	1975
Slab zinc	1,254,059	1,418,349	1,503,938	1,287,696	925,330
Ores (zinc content) [1]	119,254	118,305	129,651	127,113	82,732
Secondary (zinc content) [2]	277,381	307,369	298,336	258,204	223,753
Total	1,650,694	1,844,023	1,931,925	1,673,013	1,231,815

[1] Includes ore used directly in galvanizing.
[2] Excludes redistilled slab and remelt zinc.

Table 18.—Slab zinc consumption in the United States, by industry use
(Short tons)

Industry and product	1971	1972	1973	1974	1975
Galvanizing:					
Sheet and strip	255,335	294,205	321,927	291,008	185,795
Wire and wire rope	29,895	30,769	34,315	27,579	24,945
Tubes and pipe	65,122	64,549	68,048	59,995	47,180
Fittings (for tube and pipe)	10,240	11,106	11,969	9,294	6,359
Tanks and containers	2,759	3,645	2,941	3,203	1,917
Structural shapes	18,589	20,302	21,714	36,784	41,235
Fasteners	5,159	4,310	4,782	5,703	4,426
Pole-line hardware	8,358	8,437	8,193	6,783	4,934
Fencing, wire, cloth, and netting	20,232	21,995	25,418	26,284	20,051
Other and unspecified uses	59,063	58,886	64,530	56,636	40,045
Total	474,752	518,204	563,837	523,269	376,887
Brass products:					
Sheet, strip, and plate	78,929	105,405	109,582	99,971	64,958
Rod and wire	46,514	63,143	63,164	57,725	33,415
Tube	9,399	8,886	10,858	9,930	6,451
Castings and billets	4,479	6,840	6,000	4,431	3,079
Copper-base ingots	10,440	7,137	6,895	8,244	6,623
Other copper-base products	725	736	1,151	1,262	800
Total	150,486	192,147	197,650	181,563	115,326
Zinc-base alloy:					
Diecasting alloy	504,823	566,932	598,725	436,377	330,190
Dies and rod alloy	270	56	111	384	149
Slush and sand casting alloy	11,018	12,773	11,770	3,498	3,852
Total	516,111	579,761	610,606	440,259	334,191
Rolled zinc	38,852	45,216	40,763	39,393	27,308
Zinc oxide	40,043	51,992	61,734	65,376	39,020
Other uses:					
Light-metal alloys	4,575	6,300	7,466	9,690	5,832
Other [1]	29,240	24,729	21,882	28,146	26,766
Total	33,815	31,029	29,348	37,836	32,598
Grand total	1,254,059	1,418,349	1,503,938	1,287,696	925,330

[1] Includes zinc used in making zinc dust, wet batteries, desilverizing lead powder, alloys, chemicals, castings, and miscellaneous uses not elsewhere mentioned.

Table 19.—Slab zinc consumption in the United States in 1975, by grade and industry use
(Short tons)

Industry	Special High Grade	High Grade	Intermediate	Brass Special	Prime [1] Western	Remelt	Total
Galvanizing	21,306	18,126	6,735	75,056	255,195	469	376,887
Brass and bronze	33,937	58,797	26	3,987	18,473	106	115,326
Zinc-base alloys	332,905	608	9	55	421	193	334,191
Rolled zinc	19,377	361	7,472	--	98	--	27,308
Zinc oxide	16,717	1,126	--	--	21,177	--	39,020
Other	13,931	4,351	--	116	14,200	--	32,598
Total	438,173	83,369	14,242	79,214	309,564	768	925,330

[1] Includes select grade.

Table 20.—Rolled zinc produced and quantity available for consumption in the United States

	1974			1975		
		Value			Value	
	Short tons	Total (thousands)	Average per pound	Short tons	Total (thousands)	Average per pound
Production: [1]						
Photoengraving plate	6,367	$8,859	$0.696	2,898	$3,467	$0.598
Strip and foil	30,111	27,669	.459	21,010	22,699	.540
Total rolled zinc [2]	38,417	38,640	.503	27,725	31,155	.562
Exports	3,487	3,842	.551	1,629	2,086	.640
Imports	640	568	.445	236	507	1.074
Available for consumption	36,536	--	--	25,603	--	--

[1] Figures represent net production. In addition, 33,474 tons in 1974 and 22,153 tons in 1975 were rerolled from scrap originating in fabricating plants operating in connection with zinc-rolling mills.
[2] Includes other plate over 0.375 inch thick, sheet zinc less than 0.375 inch thick, and rod and wire. Bureau of Mines not at liberty to publish separately.

Table 21.—Slab zinc consumption in the United States in 1975, by industry and State

(Short tons)

	Galvanizers	Brass mills [1]	Die casters [2]	Other [3]	Total
Alabama	28,319	W	--	W	30,790
Arizona	W	--	--	W	W
Arkansas	W	--	--	W	W
California	27,191	2,820	W	W	38,639
Colorado	W	W	W	W	W
Connecticut	2,561	17,118	W	W	24,146
Delaware	W	W	--	W	W
Florida	4,028	--	--	--	4,028
Georgia	W	--	W	--	W
Hawaii	W	--	--	--	W
Idaho	--	--	W	W	W
Illinois	46,042	18,419	52,321	6,285	123,067
Indiana	39,468	W	W	W	96,928
Iowa	675	--	W	W	1,561
Kansas	--	W	W	W	W
Kentucky	W	W	--	W	W
Louisiana	3,517	--	W	W	4,867
Maine	W	--	--	--	W
Maryland	W	--	--	W	16,856
Massachusetts	3,359	W	W	W	5,413
Michigan	W	9,257	62,179	W	75,035
Minnesota	762	--	--	--	762
Mississippi	1,765	--	--	--	1,765
Missouri	7,839	W	W	W	11,206
Nebraska	W	W	--	W	4,669
New Jersey	2,503	4,404	W	W	16,439
New York	9,452	W	59,582	W	85,431
North Carolina	W	--	W	W	W
Ohio	61,262	W	60,211	W	129,254
Oklahoma	W	--	--	W	4,677
Oregon	1,012	W	W	W	1,564
Pennsylvania	50,106	5,603	W	W	114,842
Rhode Island	W	--	--	W	W
South Carolina	W	--	--	--	W
Tennessee	W	--	W	W	W
Texas	16,170	W	W	1,317	46,606
Utah	W	W	--	--	W
Virginia	W	W	W	W	728
Washington	734	--	--	1,599	2,333
West Virginia	15,670	W	--	W	15,893
Wisconsin	1,067	W	6,571	W	10,656
Undistributed	52,916	57,599	93,134	89,725	56,407
Total [4]	376,418	115,220	333,998	98,926	924,562

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes brass mills, brass ingot makers, and brass foundries.
[2] Includes producers of zinc-base alloy for diecastings, stamping dies, and rods.
[3] Includes slab zinc used in rolled zinc products and in zinc oxide.
[4] Excludes remelt zinc.

Table 22.—Production and shipments of zinc pigments and compounds[1] in the United States

Pigment or compound	1974				1975			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Quantity (short tons)	Value[2]			Quantity (short tons)	Value[2]	
			Total (thousands)	Average per ton			Total (thousands)	Average per ton
Zinc oxide[3]	256,355	232,542	$144,078	$620	165,400	169,485	$122,158	$721
Zinc sulfate	46,135	44,135	9,048	205	23,394	23,492	5,800	247

[1] Excludes leaded zinc oxide, lithopone, and zinc chloride; figures withheld to avoid disclosing individual company confidential data.
[2] Value at plant, exclusive of container.
[3] Zinc oxide containing 5% or more lead is classed as leaded zinc oxide.

Table 23.—Zinc content of zinc pigments[1] and compounds produced by domestic manufacturers, by source

(Short tons)

Pigment or compound	1974				1975			
	Zinc in pigments and compounds produced from—			Total zinc in pigments and compounds	Zinc in pigments and compounds produced from—			Total zinc in pigments and compounds
	Ore	Slab zinc	Secondary material		Ore	Slab zinc	Secondary material	
Zinc oxide	110,664	65,271	28,571	204,506	74,148	38,853	19,329	132,330
Zinc sulfate	4,306	--	9,570	13,876	1,739	--	4,373	6,113

[1] Excludes leaded zinc oxide, zinc sulfide, and lithopone; figures withheld to avoid disclosing individual company confidential data.

Table 24.—Distribution of zinc oxide shipments, by industry[1]

(Short tons)

Industry	1971	1972	1973	1974	1975
Rubber	124,472	129,170	129,462	108,976	96,209
Paints	24,990	27,244	26,115	17,029	11,016
Ceramics	8,125	10,702	11,678	12,177	6,300
Chemicals	18,901	22,781	26,187	35,167	17,544
Agriculture	1,615	1,101	2,044	6,066	1,847
Photocopying	34,504	36,190	38,724	34,577	24,647
Other	14,896	18,679	18,623	18,550	11,922
Total	227,503	245,867	252,833	232,542	169,485

[1] For information on leaded zinc oxide shipments prior to 1971, refer to the 1970 Minerals Yearbook.

Table 25.—Distribution of zinc sulfate shipments, by industry

(Short tons)

Year	Agriculture		Other[1]		Total	
	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
1971	16,268	13,812	33,035	28,690	49,303	42,502
1972	10,496	8,602	29,099	25,935	39,595	34,537
1973	13,909	8,353	31,288	24,902	45,197	33,255
1974	14,508	8,677	29,627	18,245	44,135	26,922
1975	8,470	3,579	15,022	5,852	23,492	9,431

[1] Includes rayon; Bureau of Mines not at liberty to publish separately.

Table 26.—Stocks of slab zinc at zinc-reduction plants in the United States, December 31

(Short tons)

	1971	1972	1973	1974	1975
At primary reduction plants	48,099	28,843	25,229	38,293	74,407
At secondary distilling plants	475	1,225	718	1,427	1,245
Total	48,574	30,068	25,947	39,720	75,652

Table 27.—Consumers stocks of slab zinc at plants, December 31, by grade

(Short tons)

Year	Special High Grade	High Grade	Inter-mediate	Brass Special	Prime Western	Remelt	Total
1974	61,379	14,784	4,205	32,395	r 98,300	95	r 211,158
1975	39,139	8,155	3,728	7,227	48,826	201	107,276

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Table 28.—Average monthly U.S., LME,[1] and European Producers' prices for Prime Western Zinc and equivalent

(Metallic zinc, cents per pound)

Month	1974			1975		
	United States	LME cash	European producer	United States	LME cash	European Producer
January	31.17	60.18	30.26	39.15	36.18	38.58
February	31.90	68.57	30.96	39.11	35.97	39.12
March	32.64	73.76	33.37	38.95	36.41	39.49
April	34.82	78.90	35.77	38.93	35.46	38.71
May	34.78	80.61	36.13	38.94	33.84	37.89
June	34.95	63.79	35.78	38.94	34.01	37.24
July	36.40	49.65	35.77	38.92	32.05	35.67
August	37.62	48.27	35.11	38.90	33.39	34.53
September	39.26	41.26	36.41	38.89	32.80	34.02
October	39.33	38.42	38.10	38.96	31.98	34.86
November	39.23	35.96	37.97	38.90	31.95	36.24
December	39.24	34.95	38.04	38.93	31.08	35.77
Average for year	35.95	56.13	35.29	38.96	33.76	36.84

[1] London Metal Exchange.

Source: Metals Week.

Table 29.—U.S. exports of zinc and zinc alloys, by country

Destination	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Unwrought zinc and zinc alloys:						
Argentina	--	--	--	--	10	$8
Belgium-Luxembourg	1,964	$1,209	4,370	$3,578	1	2
Brazil	3,050	2,376	9,094	9,474	1,714	1,628
Cambodia	--	--	72	72	--	--
Canada	1,565	804	1,333	948	619	528
Chile	462	610	988	1,511	10	22
Colombia	1,891	992	1,385	1,083	142	127
Costa Rica	673	317	678	735	6	9
Dominican Republic	106	43	293	207	55	37
Ecuador	4	2	5	10	9	12
Egypt	--	--	4	6	17	34
El Salvador	531	281	456	347	1	4
France	--	--	810	278	397	339
Germany, West	1	7	104	81	64	31

Table 29.—U.S. exports of zinc and zinc alloys, by country—Continued

Destination	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Unwrought zinc and zinc alloys—Continued						
Greece	--	--	373	$515	4	$7
Guatemala	518	$281	674	831	26	21
Indonesia	300	229	1	3	--	--
Israel	1	1	226	331	--	--
Italy	707	394	534	978	--	--
Japan	4,679	3,661	2,385	2,498	479	391
Korea, Republic of	615	355	1,301	1,385	118	50
Malaysia	108	75	11	16	--	--
Mexico	99	76	144	158	181	108
Netherlands	1,498	621	3,399	2,547	4,107	3,781
Nicaragua	112	43	226	249	2	2
Pakistan	47	51	107	70	--	--
Panama	299	145	282	300	2	11
Philippines	1,407	922	1,925	1,926	5	8
Singapore	113	81	491	530	38	57
Spain	50	31	60	34	58	47
Switzerland	964	328	12	5	--	--
Taiwan	17	14	185	173	4	10
Thailand	65	51	227	247	--	--
United Arab Emirates	--	--	6	9	21	39
United Kingdom	841	861	1,965	1,381	202	194
Venezuela	2,151	1,411	2,947	3,256	1,319	1,094
Vietnam, South	110	23	441	399	--	--
Other	192	180	413	439	16	41
Total	25,140	16,475	37,927	36,610	9,627	8,642
Wrought zinc and zinc alloys:						
Algeria	22	23	3	5	24	53
Argentina	28	21	19	26	6	9
Australia	27	29	70	113	53	91
Belgium-Luxembourg	648	350	5,143	3,220	8,159	4,113
Brazil	101	41	299	140	133	103
Canada	4,043	2,239	3,659	2,797	3,137	1,975
Chile	27	22	56	67	49	65
Colombia	33	31	58	79	58	73
Costa Rica	11	11	10	18	6	11
Dominican Republic	21	17	15	22	112	121
Ecuador	27	29	45	62	26	38
Egypt	36	25	9	10	56	79
El Salvador	72	53	11	29	2	6
France	56	62	59	77	1	1
Germany, West	302	135	30	193	63	57
Hong Kong	49	38	204	212	81	93
Indonesia	--	--	150	224	1	5
Israel	82	64	55	65	48	56
Jamaica	10	16	27	47	--	--
Japan	60	57	44	47	2	4
Lebanon	34	27	34	30	33	43
Mexico	184	249	277	209	81	84
Netherlands	3	6	572	723	10	76
New Zealand	62	43	85	91	41	47
Peru	21	25	16	23	124	312
Philippines	172	114	351	169	40	53
Singapore	9	10	40	51	5	12
South Africa, Republic of	139	137	271	369	131	191
Spain	70	59	201	257	--	--
Sweden	39	24	4	4	8	86
Syrian Arab Republic	9	7	40	39	8	10
Taiwan	86	67	61	82	13	15
Thailand	66	38	33	24	11	26
United Arab Emirates	10	12	167	337	11	19
United Kingdom	162	78	340	275	180	255
Venezuela	140	134	272	407	76	105
Other	122	156	348	543	306	406
Total	6,983	4,449	13,078	11,086	13,095	8,693

Table 30.—U.S. exports of zinc, by class

Year	Blocks, pigs, anodes, etc.				Wrought zinc and zinc alloys				Waste and scrap		Dust (blue powder)	
	Unwrought		Unwrought alloys		Sheet, plates, and strip		Angles, bars, pipes, rods, etc.					
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	14,566	$8,259	10,574	$8,216	2,480	$2,100	4,503	$2,349	6,366	$2,307	666	$410
1974	19,062	16,511	18,865	r 20,099	3,487	3,842	9,591	7,244	10,936	5,461	1,152	819
1975	6,897	5,870	2,730	2,772	1,629	2,086	11,466	6,607	4,448	1,610	603	838

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Table 31.—U.S. exports of zinc pigments

Kind	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Zinc oxide	12,245	$6,438	3,104	$2,363
Lithopone	1,185	967	917	1,060
Total	13,430	7,405	4,021	3,423

Table 32.—U.S. general imports of zinc, by country

Country	1973 Quantity (short tons)	1973 Value (thousands)	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
ORES AND CONCENTRATES (zinc content)						
Australia	7,282	$288	5,606	$652	4,044	$485
Bolivia	--	--	1	1	1,217	218
Canada	124,261	22,057	162,482	51,104	98,700	37,084
Colombia	8	(1)	1	1	8	1
Germany, West	848	147	--	--	20	7
Greenland	--	--	--	--	304	46
Honduras	6,029	539	6,232	3,184	13,362	4,936
Ireland	2,001	401	1,075	160	--	--
Japan	519	93	--	--	--	--
Mexico	34,459	5,116	24,183	7,509	9,334	3,789
Nicaragua	11,244	1,324	10,639	4,176	7,299	2,577
Peru	12,981	1,812	13,860	4,341	4,902	2,011
Thailand	--	--	13,317	1,992	5,797	882
Turkey	--	--	2,647	911	--	--
Other	2	(1)	--	--	--	--
Total	199,634	31,777	240,043	74,031	144,987	52,036
BLOCKS, PIGS, OR SLABS						
Angola	--	--	1,922	1,289	5,512	4,354
Australia	42,076	19,256	38,909	29,903	22,875	17,295
Belgium-Luxembourg	40,128	21,359	30,379	31,253	19,084	16,456
Bulgaria	221	199	--	--	--	--
Canada	344,819	148,302	270,156	182,714	181,692	134,010
China, People's Republic of	--	--	--	--	298	194
Ecuador	121	46	--	--	--	--
Finland	14,183	5,581	10,590	6,998	19,157	14,264
France	10,727	5,705	4,477	5,271	1,837	1,232
Germany, West	8,203	4,562	8,289	8,008	17,827	12,507
Hong Kong	--	--	110	109	--	--
Italy	--	--	7,911	9,683	7,299	5,137
Japan	42,668	19,039	52,674	57,651	7,202	5,724
Liberia	--	--	2,731	2,008	3,601	2,502
Malaysia	--	--	--	--	45	660
Mexico	1,913	732	23,515	21,750	17,605	12,818
Mozambique	--	--	558	364	--	--
Netherlands	3,229	2,095	5,228	5,708	15,123	10,208
Norway	220	300	149	112	--	--
Peru	19,343	7,171	31,101	24,807	19,128	12,917
Poland	18,388	9,279	9,253	10,311	440	292
Singapore	--	--	229	r 204	--	--
South Africa, Republic of	329	264	774	615	2,077	1,698
Spain	11	10	5,059	4,832	26,268	16,143
U.S.S.R	3,599	2,777	221	261	--	--
United Kingdom	9,028	5,868	5,117	4,677	2,200	1,528
Yugoslavia	8,997	9,245	12,348	14,770	7,009	4,557
Zaire	28,440	12,488	17,838	11,772	4,158	2,841
Zambia	273	140	--	--	--	--
Other	130	47	--	--	--	--
Total	592,046	274,465	539,538	435,070	380,437	277,337

r Revised.
1 Less than ½ unit.

Table 33.—U.S. imports for consumption of zinc, by country

Country	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
ORES AND CONCENTRATES [1] (zinc content)						
Argentina	3	(2)	6	$1	--	--
Australia	1,248	$181	4,134	522	22,954	$1,949
Bolivia	5	1	1	(2)	1,217	218
Brazil	97	15	--	--	--	--
Canada	88,433	15,199	73,635	18,678	209,150	57,888
Colombia	--	--	--	--	8	1
Germany, West	848	147	--	--	20	7
Guatemala	673	101	--	--	--	--
Honduras	15,987	2,325	18,033	3,793	43,224	13,040
Ireland	2,021	402	883	152	4,820	750
Japan	--	--	5	1	--	--
Mexico	30,985	4,344	26,647	6,480	61,656	16,037
Nicaragua	1,330	155	1,489	236	36,749	8,858
Peru	12,544	1,838	8,900	1,567	20,633	3,991
Thailand	--	--	--	--	25,143	5,172
Turkey	--	--	--	--	2,970	911
Total	154,174	24,708	133,733	31,430	428,544	108,822
BLOCKS, PIGS, OR SLABS						
Angola	--	--	1,922	1,289	--	--
Australia	41,415	18,892	38,909	29,903	22,875	17,295
Belgium-Luxembourg	39,632	20,963	30,379	31,253	17,430	14,417
Bulgaria	221	199	--	--	--	--
Canada	344,819	148,302	278,075	184,095	181,725	134,015
China, People's Republic of	--	--	--	--	298	194
Ecuador	121	46	--	--	--	--
Finland	14,183	5,581	10,590	6,998	19,157	14,264
France	10,671	5,667	4,477	5,271	1,837	1,232
Germany, West	8,203	4,562	8,177	7,890	17,853	12,538
Hong Kong	--	--	110	109	--	--
Italy	--	--	7,635	9,404	5,792	4,202
Japan	42,668	19,039	50,827	55,919	8,403	6,832
Liberia	--	--	2,731	2,008	3,601	2,502
Malaysia	--	--	--	--	45	660
Mexico	1,913	732	25,675	21,982	14,187	10,083
Mozambique	--	--	558	364	--	--
Netherlands	3,036	1,997	4,895	5,279	15,123	10,208
Norway	220	300	149	112	--	--
Peru	19,343	7,171	31,101	24,807	19,128	12,917
Poland	r 13,498	9,332	8,922	9,968	661	496
Portugal	--	--	--	--	104	87
Singapore	--	--	229	204	--	--
South Africa, Republic of	329	264	774	615	2,077	1,698
Spain	11	10	2,413	2,540	28,509	18,895
Taiwan	221	112	--	--	--	--
U.S.S.R	3,599	2,777	221	261	--	--
United Kingdom	8,808	5,757	5,447	4,938	2,200	1,528
Yugoslavia	8,997	9,245	11,752	14,269	7,390	4,861
Zaire	28,440	12,488	17,838	11,772	6,527	4,712
Zambia	273	140	--	--	--	--
Other	130	47	--	--	--	--
Total	590,751	273,623	543,806	431,250	374,922	273,636

r Revised.

[1] Does not include zinc ores and concentrates for refining and export: 1973: Canada 3,979 short tons ($790,625); Mexico 11,816 short tons ($1,832,675); Honduras 875 short tons ($126,607); Nicaragua 5,431 short tons ($363,030); Peru 1,287 short tons ($516,447); Ireland 156 short tons ($15,467). 1974 and 1975: none.

[2] Less than ½ unit.

Table 34.—U.S imports for consumption of zinc, by class

	Ore (zinc content)		Blocks, pigs, slabs [1]		Sheets, plates, strips, other forms		Waste and scrap	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1973	154,174	$24,708	590,751	$273,623	236	$159	r 1,544	r $597
1974	133,733	31,430	543,806	431,250	640	568	2,418	1,241
1975	428,544	108,822	374,922	273,636	236	507	1,418	468

	Dross and skimmings (zinc content)		Zinc fume (zinc content)		Dust, powder, and flakes		Total value [2] (thousands)
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	
1973	2,328	$506	17,953	$2,810	4,873	$2,468	r $304,871
1974	3,863	1,786	18,235	3,283	9,131	9,799	479,357
1975	3,158	1,238	33,327	9,442	5,739	5,744	399,857

r Revised.
[1] Unwrought alloys of zinc were imported as follows: 1973, 1,346 short tons ($709,322); 1974, 11,491 short tons ($11,397,967); 1975, 101 short tons ($87,395).
[2] In addition, manufactures of zinc were imported as follows: 1973, $607,998; 1974, $562,521; 1975, $78,837.

Table 35.—U.S. imports for consumption of zinc pigments and compounds

Kind	1974 Quantity (short tons)	1974 Value (thousands)	1975 Quantity (short tons)	1975 Value (thousands)
Zinc oxide	26,088	$19,427	13,187	$8,162
Zinc sulfide	789	473	328	214
Lithopone	262	139	15	6
Zinc chloride	2,227	1,264	767	518
Zinc sulfate	7,906	2,439	3,191	1,065
Zinc cyanide	116	149	10	15
Zinc hydrosulfite	74	59	--	--
Zinc compounds, n.s.p.f	1,974	2,098	949	766
Total	39,436	26,048	18,447	10,746

Table 36.—Zinc: World mine production (content of ore), by country

(Short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Canada [2]	1,352,074	1,278,139	1,193,809
Guatemala (exports)	309	--	--
Honduras	21,681	26,411	33,398
Mexico	299,137	289,594	252,265
Nicaragua	r 20,604	16,334	12,321
United States [3]	478,850	499,872	469,355
South America:			
Argentina	44,749	44,175	38,471
Bolivia [4]	57,038	53,145	51,040
Brazil	r 36,217	42,255	33,069
Chile	1,766	3,692	3,499
Colombia	161	41	e 110
Ecuador	--	223	e 220
Peru	r 454,000	408,000	397,000
Europe:			
Austria	24,417	23,123	25,397
Bulgaria [e]	88,000	r 88,000	93,000
Czechoslovakia	r 9,905	10,296	13,000
Finland	64,587	64,857	58,148
France	14,705	15,939	14,400
Germany, East [e]	r 3,300	(5)	--
Germany, West	r 135,368	127,916	e 127,800
Greece	20,765	27,018	16,212
Greenland	29,983	116,051	100,156
Hungary [e]	r 4,400	r 4,400	5,300
Ireland	75,828	73,136	73,472
Italy	r 86,600	85,500	83,400
Norway	21,839	24,661	27,138
Poland	r 231,000	220,000	238,000
Portugal	r 769	--	--
Romania (recoverable) [e]	r 66,000	r 66,000	66,000
Spain	r 96,184	93,685	92,744
Sweden	130,670	125,332	125,332
U.S.S.R. [e]	740,000	750,000	760,000
United Kingdom	r 3,200	3,300	3,400
Yugoslavia	107,396	104,369	e 111,000
Africa:			
Algeria	r 13,455	10,100	13,000
Congo, Republic of [e]	r 3,600	r 3,600	2,600
Morocco	r 20,171	17,940	23,678
South Africa, Republic of	18,757	41,222	77,374
South West Africa, Territory of [6]	41,798	42,395	37,700
Tunisia	r 9,472	9,295	e 7,500
Zaire	r 96,517	93,106	78,817
Zambia	r 80,700	88,700	73,400
Asia:			
Burma	4,202	4,807	4,464
China, People's Republic of [e]	110,000	110,000	110,000
India	13,682	16,657	e 21,000
Iran [7]	r 78,800	90,900	72,800
Japan	290,964	265,423	284,582
Korea, North [e]	176,000	179,000	179,000
Korea, Republic of	r 53,077	44,901	50,617
Philippines	5,921	8,567	12,000
Thailand [8]	73	36,900	e 5,000
Turkey	24,486	29,632	20,819
Oceania:			
Australia	r 529,640	502,438	e 542,000
New Zealand	r 667	--	--
Total	r 6,293,484	6,281,047	6,131,082

e Estimate. p Preliminary. r Revised.

1 In addition to the countries listed, North Vietnam also produces zinc, but information is inadequate to make reliable estimates of output levels.

2 Zinc content of concentrates.

3 Recoverable metal.

4 Sum of production of COMIBOL and exports by medium and small mines.

5 Revised to zero.

6 Data are compiled from company reports of Tsumeb Corp. Ltd., South-West Africa Co. Ltd. (ISCOR) for Imcor Zinc (Pty.) Ltd.'s Rosh Pinah mine. Data from Tsumeb Corp. Ltd. are for calendar years; data from other companies are for fiscal years ending June 30 of the year stated.

7 Year beginning March 21 of that stated.

8 Contained in zinc concentrates. Additional quantities of zinc may be contained as a byproduct in lead concentrates produced, but information is inadequate to make reliable estimates of such production, if any.

Table 37.—Zinc: World smelter production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
North America:			
Canada	587,038	469,883	470,600
Mexico	78,730	147,013	164,270
United States	583,479	555,188	438,051
South America:			
Argentina	[r] 36,700	41,000	43,400
Brazil	[r] 24,582	33,641	26,000
Peru	[r] 76,770	77,900	73,400
Europe:			
Austria [2]	18,738	18,133	17,938
Belgium [2]	309,846	323,603	252,692
Bulgaria [2]	88,000	88,000	99,200
Finland	88,915	101,177	121,127
France	285,915	304,806	232,553
Germany, East [e] [2]	[r] 16,500	20,000	20,000
Germany, West	[r] 283,297	292,846	[e] 218,000
Italy	200,633	216,515	197,460
Netherlands	[r] 33,618	86,196	186,623
Norway	[r] 89,236	79,845	66,796
Poland [2]	259,000	257,000	268,000
Romania [e]	72,000	[r] 77,000	73,000
Spain	118,024	143,307	147,010
U.S.S.R.[e]	740,000	750,000	760,000
United Kingdom	[r] 92,400	93,000	70,636
Yugoslavia [2]	[r] 60,920	95,218	107,900
Africa:			
Algeria	--	9,000	9,000
South Africa, Republic of	[r] 58,500	72,100	70,000
Zaire	74,678	73,886	68,000
Zambia	58,814	64,307	[e] 52,000
Asia:			
China, People's Republic of [e]	110,000	110,000	110,000
India	14,010	23,262	28,366
Japan	929,224	936,850	773,600
Korea, North [e]	143,000	[r] 143,000	152,000
Korea, Republic of	13,878	12,729	23,063
Oceania: Australia	[r] 330,090	305,154	[e] 208,000
Total	[r] 5,876,535	6,021,559	5,498,685

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, North Vietnam also produces zinc, but available information is inadequate to make reliable estimates of output levels.
[2] Includes production from reclaimed scrap.

Table 38.—World zinc smelters and capacities, yearend 1975
(Thousand short tons)

Country, company, plant location	Type	Annual capacity for slab zinc
NORTH AMERICA		
Canada:		
Canadian Electrolytic Zinc Ltd., Valleyfield, Quebec	Electrolytic	225
Cominco Ltd., Trail, British Columbia	do	270
Hudson Bay Mining & Smelting Ltd., Flin Flon, Manitoba	do	79
Texasgulf Canada Ltd., Timmins, Ontario	do	120
Total Canada		694
Mexico:		
Industrial Minera Mexico, S.A., Rosita, Coahuila	Horizontal retort	68
Industria Peñoles, S.A., Torreon, Coahuila	Electrolytic	116
Zincamex, S.A., Saltillo, Coahuila	Horizontal retort	33
Total Mexico		217
United States:		
AMAX Zinc Co., Inc., Sauget, Ill	Electrolytic	84
ASARCO Incorporated, Corpus Christi, Tex	do	100
The Bunker Hill Co., Kellogg, Idaho	do	104
National Zinc Co., Bartlesville, Okla	Horizontal retort	56
New Jersey Zinc Co., Palmerton, Pa	Vertical retort	118
St. Joe Minerals Corp., Monaca, Pa	Electrothermic	190
Total United States		652
Total North America		1,563
SOUTH AMERICA		
Argentina:		
Cia. Metallurgica Austral, S.A., Comodoro Rivadavia	Electrothermic	18
Establecimentos Met Meteor, Zarate	Electrolytic	10
Sulfacid, S.A.C.I., Borghi	do	29
Total Argentina		57
Brazil:		
Cia. Mercantil e Indústrial Inga, Itaguai	Electrolytic	15
Cia. Mineira de Metais, Tres Marias	do	28
Total Brazil		43
Peru: Centromin Peru, La Oroya	Electrolytic	83
Total South America		183
EUROPE		
Austria: Bleiberger Bergwerks Union, A.G., Galitz	Electrolytic	19
Belgium:		
Métallurgie Hoboken-Overpelt, S.A., Overpelt	do	110
Sté. des Mines et Fonderies de Zinc de la Vieille-Montagne, S.A., Balen	do	185
Sté. de Prayon, S.A., Ehein	do	66
Total Belgium		361
Bulgaria: K.S.M. Dimitar Blogoev:		
Kurdjali	Electrolytic	66
Plodov	do	33
Total Bulgaria		99
Czechoslovakia:		
Banská Stiavnica Smelter, Banská Stavnica	Unknown	NA
Chuderice Smelter, Chuderice	do	NA
Pribram Smelter, Pribram	do	NA
Total Czechoslovakia		44
Finland: Outokumpu Oy, Kokkola	Electrolytic	165
France:		
Cie. Royale Asturienne des Mines, S.A., Auby	Vertical retort	116
Sté. Minière et Métallurgique de Peñarroya, Noyelles-Godault	Imperial	99

See footnotes at end of table.

Table 38.—World zinc smelters and capacities, yearend 1975—Continued

(Thousand short tons)

Country, company, plant location	Type	Annual capacity for slab zinc,
EUROPE—Continued		
France—Continued		
Sté. des Mines et Fonderies de Zinc dé la Vielle-Montagne, Viviez	Electrolytic	110
Total France		325
Germany, East: V.E.B. Buntmetall, Bitterfeld	Electrolytic	22
Germany, West:		
Berzelius Metalhütten, G.m.b.h., Duisberg-Wanheim	Imperial	88
Duisburger Kupferhütte, G.m.b.h., Duisberg	Electrothermic	22
Preussag-Weser-Zink G.m.b.h:		
Harlingerade	Vertical retort	104
Nordenham	Electrolytic	121
Ruhr-Zinc, G.m.b.h., Datteln	do	143
Total Germany, West		478
Italy:		
Ammi S.p.A.:		
Monteponi	Electrolytic	17
Ponte Nossa	do	39
Porto Marghera	do	50
Ammi Sarda S.p.A., Portovesme	Imperial	77
Stá. Mineraria e Metallurgica de Petrusola, Crotone	Electrolytic	88
Total Italy		271
Netherlands:		
Kempensche-Zinkmaatschappij, B.V., Budel	Electrolytic	165
Norway: Det Norske Zinkkompani, A/S, Eitrheim	do	99
Poland:		
Boleslaw United Mining and Metallurgy Works, Boleslaw	do	94
Miastecko Slaskie Zinc Works, Jarnowskie-Gorp	Imperial	66
Silesia Zinc Works, Katowice	Horizontal retort	50
Szopienice Non Ferrous Metal Works, Szopienice	Electrolytic	88
Trzebini Metallurgical Works, Trzebina	Unknown	39
Total Poland		337
Romania: Uzina Chimica Metalurgica, Copsa Mica	Imperial	66
Spain:		
Asturiana de Zinc S.A., San Juan de Nieva	Electrolytic	121
Española del Zinc, S.A., Cartagena	do	33
Total Spain		154
U.S.S.R.:		
Almalyk Smelter, Vzbekistan	Electrolytic	121
Belovski Smelter, Siberia	Horizontal retort	55
Cheliabinski Smelter, Cheliabinsk	Electrolytic	165
Kemerova Smelter, Kemerova	Unknown	33
Konstantinovka Smelter, Ukraine	Electrolytic	33
Leninogorsky Kombinat, Kazakhstan	do	88
Ordzkhonikidze Smelter, North Caucasus	do	143
Tetiukha Smelter, Primorskiy Kray	Unknown	22
Ustig-Kamenogorski Kombinat, Kazakhstan	Electrolytic	165
Total U.S.S.R		825
United Kingdom:		
Commonwealth Smelting Ltd., Avonmouth	Imperial	110
Yugoslavia:		
Hemijska Industria "Zorka", Sabac	Electrolytic	28
Rudarsko-Metalurskó Hemijski Kombinat "Trepca", Kosovska Mitrovica	do	44
Zletovo, Topilnica Za Cinki Olova, Titov Veles	Imperial	72
Total Yugoslavia		144
Total Europe		3,684
ASIA		
China, People's Republic of:		
Shao-Kuan Smelter, Kwangtung	do	44
Shenyang Smelter, Liaoning	Electrolytic	22
Sungpai Smelter, Hunan	Unknown	6
Total China, People's Republic of		[1] 120

See footnotes at end of table.

Table 38.—World zinc smelters and capacities, yearend 1975—Continued

(Thousand short tons)

Country, company, plant location	Type	Annual capacity for slab zinc
ASIA—Continued		
India:		
Cominco Binani Zinc Ltd., Kerala	Electrolytic	22
Hindustan Zinc Ltd., Debari	do	20
Total India		42
Japan:		
Akita Zinc Co. Ltd., Iijima	Electrolytic	172
Hachinohe Smelting Co. Ltd., Hachinohe	Imperial	81
Mitsubishi Metal Corp.:		
Akita-shi	Electrolytic	100
Hosokura	do	24
Mitsui Mining & Smelting Co. Ltd.:		
Kamioka	Electrothermic	6
Do	Electrolytic	69
Omuta	do	24
Hikoshima	do	93
Miiki	Vertical retort	130
Nippon Mining Co. Ltd., Mikkaichi	do	132
Nisso Smelting Co. Ltd., Aizu	Electrolytic	33
Sumiko ISP Co., Harima	Imperial	66
Toho Zinc Co. Ltd., Annaka-shi	Electrolytic	154
Total Japan		1,084
Korea, North: Korea Metals and Chemicals, Export and Import Corp., Nampo	Electrolytic	154
Korea, Republic of:		
Yongpoong Mining Co. Ltd., Sekiho	do	23
Tong Shin Chemical Co., Seoul	do	7
Total Korea, South		30
Total Asia		1,430
AFRICA		
Algeria: Ghazaouet Smelter, Ghazaouet	Electrolytic	22
South Africa, Republic of: Zinc Corp. of South Africa Ltd., Vogelstuisbuilt	do	83
Zaire: Sté. Métalurgique de Kolwezi, Kolwezi	do	75
Zambia:		
Nchanga Consolidated Copper Mines Ltd.:		
Kabwe	do	39
Do	Imperial	35
Total Zambia		74
Total Africa		254
AUSTRALIA		
Australia:		
The Broken Hill Associated Smelters Pty., Ltd., Port Pirie, So. Australia	Electrolytic	50
Electrolytic Zinc Co. of Australasia Ltd., Risdon, Tasmania	do	230
Sulphide Corp. Pty., Ltd., Cockle Creek, New South Wales	Imperial	77
Total Australia		357
Total World		7,471

NA Not available.
[1] Includes additional capacity from small complexes.

Zirconium and Hafnium

By Sarkis G. Ampian [1]

Zircon production and sales by domestic mining companies decreased nearly 30% in tonnage in 1975, and nearly doubled in value above that of 1974. Zircon exports decreased 13% from 21,487 tons in 1974 to 18,766 tons in 1975, while imports decreased 36% from 62,504 short tons in 1974 to 40,205 short tons in 1975. Exports of zirconium metal and alloys and zirconium oxide generally increased in 1975. Production of zirconium-bearing compounds for chemicals and refractories also increased slightly. Zircon consumption by foundries decreased from 80,000 short tons in 1974 to 46,200 tons in 1975. Some hafnium was also produced.

The 1975 worldwide zircon supply-demand picture was characterized by a softening in demand owing to the downturn in industrial activity coupled with an increase in Australian production capacity; the result was an oversupply, which depressed prices. Domestically, zircon reflected the worldwide situation except for the continued strong demand largely in manufacturing specialized refractories and abrasives.

Recycling of spent foundry zircon and substitution with chromite and aluminum silicate minerals for some zircon foundry applications were also commonplace.

Zircon use was primarily in foundry sands, refractories, abrasives, ceramics, and as a source of zirconium metal. The metal was used mostly in nuclear reactors and in corrosion-resistant equipment for industrial plants, and in refractory alloys. Hafnium was used in nuclear reactors, flashbulbs, and refractory alloys.

Legislation and Government Programs.—The Statistical Supplement to the Stockpile Report to Congress, December 31, 1974, showed no objectives for zirconium and hafnium materials. The U.S. Energy Research and Development Administration at its Pittsburgh Naval Reactors Office had on inventory as of June 30, 1975, approximately one-half ton of zirconium crystal bar and scrap, 937 tons of zirconium sponge, 163 tons of Zircaloy ingot and shapes, one-half ton of hafnium scrap; 5 tons of hafnium oxide; one-half ton of hafnium sponge and shapes; and 39 tons of hafnium crystal bar.

The Food and Drug Administration (FDA), insisting that the safety of zirconium-bearing compounds in antiperspirants has not been demonstrated, has proposed implementing a ban on the sale of these aerosol products. FDA officials were concerned that inhalation of the minute zirconium compound particles could cause chronic lung disease.[2] Although the ban has not yet taken effect and industry spokesmen continue to present scientific data confirming the safety of these products, reformulation of the products has been started reluctantly. The European Commission, studying the FDA report on banning zirconium compounds in deodorants, was contemplating proposals for governing their use in the community.[3]

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[1] Physical scientist, Division of Nonmetallic Minerals.

[2] U.S. Food and Drug Administration. Aerosol Drug and Cosmetic Products Containing Zirconium. Federal Register, v. 40, No. 109, Part 3, June 5, 1975, pp. 24327–24344.

[3] European Chemical News. ECN Newsdesk-Newsbriefs. V. 27, No. 689, June 6, 1975, p. 8.

Table 1.—Salient zirconium statistics in the United States
(Short tons)

Product	1971	1972	1973	1974	1975
Zircon:					
Production	W	W	W	W	W
Exports	9,429	17,360	28,921	21,487	18,766
Imports	96,387	67,537	98,023	62,504	40,205
Consumption [e] [1]	166,000	168,000	175,000	167,000	122,000
Stocks, yearend, dealers and consumers [2]	42,500	44,500	51,500	41,900	37,033
Zirconium oxide:					
Production [3]	10,770	12,020	14,300	11,630	11,760
Producers' stocks, yearend [3]	680	942	648	1,480	1,745

[e] Estimate. W Withheld to avoid disclosing individual company confidential data.
[1] Includes baddeleyite: 1971—871 tons; 1972—385 tons; 1973—1,019 tons; 1974—[e] 2,950 tons; 1975—[e] 1,000.
[2] Excludes foundries.
[3] Excludes oxide produced by zirconium metal producers.

DOMESTIC PRODUCTION

E. I. du Pont de Nemours & Co. and Titanium Enterprises, Inc., were the only major producers of zircon mineral concentrate in the United States. Zircon was recovered from mineral sands at the dredging and mining facilities owned by du Pont at Starke, Fla.; by Humphreys Mining Co. for du Pont, near Folkston, Ga.; and Titanium Enterprises at Green Cove Springs, Fla. Production data were withheld from publication to avoid disclosing individual company confidential data. The combined zircon capacity of these three plants is estimated to be 135,000 tons per year.

Humphreys Mining Co.'s new mining and wet-mill operations near Boulougne, Fla., were fully operational. The company's zircon dry mill was still located at Folkston. Du Pont completed its new facility for producing Zircore, its popular new low-cost zircon-aluminum silicate foundry sand. Titanium Enterprises' new dredge was performing up to expectations.

NL Industries, Inc., continued feasibility studies on recovering heavy minerals from the Trail Ridge Extension in Florida. NL planned to use a bucket-wheel floating suction dredge instead of the more conventional cutter-head type to facilitate mining in the indigenous hardpan. A decision on the project was expected by the end of 1976.

Ethyl Corp.'s plans for recovering heavy minerals, zircon, monazite, rutile, and ilmenite from deposits in the vicinity of Kentucky Lake in west Tennessee near Paris Landing in Henry County, was deferred until the markets for black sands improve. In spite of opposition by the press and environmental groups, Ethyl Corp. purchased additional land for the projected 2,000-acre mining area.[4]

Statistical data on production of zirconium sponge, ingot, and scrap and on hafnium sponge and oxide are also withheld to avoid disclosure of company confidential data. Approximately 2,300 tons of alloys containing from 3% to 70% zirconium was produced in 1975.

Three firms produced 30,080 tons of milled (ground) zircon, a decrease of 17% from the reported 1974 production. Six companies, excluding those that produce metal, produced 11,760 tons of zirconium oxide. Oxide production in 1975 rose slightly more than 1% over that reported in 1974.

Hafnium crystal bar, produced by two firms, was estimated at 30 tons, compared with 40 tons in 1974.

[4] Hardeman, W. D. Tennessee. State Liaison Officers News Bull. October 1975, p. 44.

Table 2.—Producers of zirconium and hafnium materials in 1975

Company	Location	Materials
ZIRCONIUM MATERIALS		
AMAX Specialty Metals Corp	Akron, N.Y	Ingot, sponge.
Do	Parkersburg, W. Va	Sponge, metal chloride, oxide.
Babcock & Wilcox Co., Nuclear Materials Div	Parks Township, Pa	Powder, alloys.
Barker Foundry Supply Co	Los Angeles, Calif	Milled zircon.
The Carborundum Co	Falconer, N.Y	Refractories.
C. E. Refractories, Div. of Combustion Engineering, Inc.	St. Louis, Mo	Do.
	King of Prussia, Pa	Refractories, zircon.
Continental Mineral Processing Corp	Sharonville, Ohio	Milled zircon.
Corhart Refractories Co	Buckhannon, W. Va	Refractories.
Do	Corning, N.Y	Do.
Do	Louisville, Ky	Do.
E. I. du Pont de Nemours & Co	Wilmington, Del	Zircon, foundry mixes.
Foote Mineral Co	Cambridge, Ohio	Alloys.
A. P. Green Refractories Co., Remmey Div	Philadelphia, Pa	Refractories.
Harbison-Walker Refractories Co	Mount Union, Pa	Do.
Harshaw Chemical Co., Inc	Cleveland, Ohio	Oxide, ceramics.
Hercules, Inc., Drakenfeld Div	Washington, Pa	Ceramic colors, milled zircon.
Ionarc/TAFA	Bow, N.H	Oxide.
M & T Chemicals, Inc	Andrews, S.C	Milled zircon.
Magnesium Electron, Inc	Secaucus, N.J	Alloys, chemicals.
NL Industries, Inc., Titanium Alloy Manufacturing Div. (TAM)	Niagara Falls, N.Y	Milled zircon, oxide alloys, chloride.
Charles Taylor Division	Cincinnati, Ohio	Refractories.
Do	South Shore, Ky	Do.
Norton Co	Huntsville, Ala	Oxide.
Ohio Ferro-Allo Corp	Brillant, Ohio	Alloys.
Ronson Metals Corp	Newark, N.J	Baddeleyite (oxide).
Sherwood Refractories Co	Cleveland, Ohio	Zircon cores.
Shieldalloy Corp	Newfield, N.J	Welding rods, alloys.
Stauffer Chemical Co	Niagara Falls, N.Y	Chloride.
Teledyne Wah Chang Albany Corp	Albany, Oreg	Oxide, chloride, sponge, ingot, powder, crystal bar.
Titanium Enterprises, Inc	Green Cove Springs, Fla	Zircon.
Tizon Chemical Corp	Flemington, N.J	Oxide, chemicals.
Transelco, Inc	Dresden, N.Y	Chemicals, ceramics.
Union Carbide Corp	Alloy, W. Va. and Niagara Falls, N.Y.	Alloys.
Ventron Corp	Beverly, Mass	Alloys, oxide, sponge.
Zedmark, Inc	Butler, Pa	Refractories.
Zirconium Corp. of America	Cleveland, Ohio	Oxide, refractories, ceramics.
HAFNIUM MATERIALS		
AMAX Specialty Metals Corp	Akron, N.Y	Sponge, crystal bar, ingot, scrap.
Do	Parkersburg, W. Va	Oxide.
Babcock & Wilcox Co., Nuclear Materials Div	Leechburg, Pa	Crystal bar.
Teledyne Wah Chang Albany Corp	Albany, Oreg	Oxide, sponge, crystal bar, ingot.

CONSUMPTION AND USES

Zircon consumption in the United States in 1975 was estimated at 122,000 tons. Consumption of zircon concentrate and milled zircon was 46,200 tons for foundries, 40,000 tons for refractories, 15,000 tons for zirconium oxide, 2,800 tons for zirconium alloys (excluding zirconium-base alloys), and 18,000 tons for all other uses. Foundries consumed approximately one-half of the domestic zircon production, with the remaining one-half consumed by refractory, abrasive, ceramic, metal, and other industries. Domestic zircon was marketed in proprietary mixtures for use as weighting agents, zircon-TiO_2 blends for welding-rod manufacture, and zircon-refractory heavy-mineral (kyanite, sillimanite, and staurolite) sand blends for foundry sand and sandblasting applications. The zircon-bearing foundry sand was reportedly designed to provide consistent high-quality performance at low cost for critical casting applications.

Imported Republic of South Africa baddeleyite ore in 1975 was used principally in the manufacture of alumina-zirconia abrasives and also in ceramic colors, refractories, and for other uses.

Preliminary Bureau of the Census figures for 1975 showed that shipments of zircon and zirconia brick and shapes, composed mostly of these materials, totaled 2.1 million brick, expressed in terms of equivalent 9-inch brick, valued at $16.7 million. In 1974, final figures for shipments were 2.7 million brick valued at $11.4 million.[5]

Zirconium metal was used in nuclear reactors, in chemical plants for corrosion-resistant material, in refractory alloys, and in photography for flashbulbs.

Zirconium compounds, natural and manufactured, were used in refractories, glazes, enamels, welding rods, chemicals, and sandblasting. Zirconium chemicals were finding increasing applications in the paint, textile, and pharmaceutical industries. Hafnium metal, alloys, and compounds continued to have few uses. The metal was used for nuclear reactor control rods, in special refractory alloys, and in photographic flashcubes. The nonnuclear hafnium metal uses were reportedly increasing.

[5] Bureau of the Census. Refractories. Quarterly, 1975.

Table 3.—Zircon consumption in selected zirconium materials as reported by producers in the United States in 1975
(Short tons)

Use	Quantity
Zircon refractories [1]	28,000
AZS refractories [2]	12,000
Zirconia [3]	15,000
Alloys [4]	2,800
Foundry aids	46,200
Other [5]	18,000
Total	122,000

[1] Dense and pressed zircon brick and shapes.
[2] Fused cast and bonded alumina-zirconia-silica-base refractories.
[3] Excludes oxide produced by zirconium metal producers.
[4] Exludes alloys above 90% zirconium.
[5] Includes chemicals, metallurgical-grade zirconium tetrachloride, sandblasting, and welding rods.

Table 4.—Zirconium oxide [1] consumption in selected zirconium materials as reported by producers in the United States in 1975
(Short tons)

Use	Quantity
AZ abrasives [2]	6,800
AZS refractories [3]	2,500
Other refractories	1,700
Chemicals	280
Glazes, opacifiers, and colors	480
Total	11,760

[1] Excludes oxide produced by zirconium metal producers.
[2] Alumina- and zirconia-based abrasives.
[3] Fused cast and bonded.

Table 5.—Yearend stocks of zirconium and hafnium materials
(Short tons)

Item	1974	1975
Zircon concentrate held by dealers and consumers excluding foundries	35,400	32,312
Milled zircon held by dealers and consumers, excluding foundries	6,500	4,721
Zirconium:		
Oxide [1]	1,480	1,745
Sponge	771	193
Ingot	507	38
Scrap	1,124	191
Alloys	173	851
Refractories	9,534	6,495
Hafnium: [e]		
Sponge	40	45
Crystal bar	10	11

[e] Estimate.
[1] Excludes oxide held by zirconium metal producers.

PRICES

Published prices for regular-grade domestic zircon remained unchanged at $257 per ton during the year. Foreign zircon also remained steady at nearly $600 per ton. Prices of zirconium oxides were either unchanged or unlisted for the entire year. The prices of zirconium chemicals and zirconium sponge, powder, sheet, and hafnium metal, sponge, and nitride were unchanged. The baddeleyite price, furnished by Ronson Metals Corp., advanced slightly during the year.

The Australian Department of Minerals and Energy at a November meeting reduced the minimum export price of zircon sand in bulk, containing 0.1% or more iron oxide (essentially West Coast material), from $A200 per metric ton to $A140 and $A150 per metric ton ($A1=U.S. $1.31) for material containing less than 0.1% iron oxide (East Coast material). The new prices apply to new contracts for standard grades of zircon for 1976 delivery. Premium-grade East Coast material, containing maximum 0.05% Fe_2O_3 and maximum 0.1% TiO_2, will sell at about $A10–20 per metric ton higher.[6] At the end of 1974, the spot price for standard-grade Australian zircon was around $A400 per metric ton free in Australian Container Depot (FID). Prices had risen rapidly in 1974 when a shortage developed because of a large increase in demand by the Japanese steel industry for zircon-bearing ladle refractories.

[6] Industrial Minerals (London). Comment-New Plans for Zircon. No. 98, November 1975, pp. 7, 49.

Table 6.—Published prices of zirconium and hafnium materials in 1975

Specification of material	Price
Zircon:	
Domestic, f.o.b. Starke, Fla. (Folkston, Ga.), bags, per short ton[1]	$257.00
Domestic, 75% minimum quantity zircon and aluminum silicates, Starke, Fla. (Folkston, Ga.), bulk, per short ton[2]	119.00
Imported sand, containing 65% ZrO_2, c.i.f. Atlantic ports, bags, per long ton[2]	560.00
Domestic, granular, 30-ton lots, from works, bags, per short ton[3]	$435.00– 440.00
Domestic, milled, 18-ton lots, from works, bags, per short ton[3]	490.00– 495.00
Baddeleyite imported concentrate:	
98% to 99% ZrO_2, minus 100-mesh, c.i.f. Atlantic ports, per pound[4]	.18– .25
99+% ZrO_2, minus 325-mesh, c.i.f. Atlantic ports, per pound[4]	.56– .72
Zirconium oxide:	
Powder, commercial-reactor grade, drums, from works, bags, per pound[3]	NA
Chemically pure white ground, barrels or bags, works, per pound[3]	2.22
Lump, electric fused, bags, 500- to 1,999-pound lots, from works, per pound[3]	NA
Lump, electric fused, bags, smaller lots, from works, per pound[3]	NA
Milled, bags, carlots, from works, per pound[3]	NA
Glass-polishing grade, ton lots, bags, 94% to 97% ZrO_2, from works, per pound[3]	1.11
Opacifier grade, 3,300-pound lots, 85% to 90% ZrO_2, bags, per pound[3]	.81
Stabilized oxide, 100-pound bags, 91% ZrO_2, milled, per pound[3]	1.57
Zirconium oxychloride: Crystal, cartons, 5-ton lots, from works, per pound[3]	.515
Zirconium acetate solution:	
13% ZrO_2, drums, carlots, 15-ton minimum, from works, per pound[3]	.22
22% ZrO_2, same basis, per pound[3]	.38
Zirconium hydride: Electronic grade, powder, drums, 100- to 990-pound lots, from works, per pound[3]	14.50– 16.00
Zirconium:	
Powder, per pound[5]	16.00
Sponge, per pound[2 5]	5.50– 7.00
Sheets, strip, bars, per pound[2 5]	10.00– 17.00
Billet bar, per pound[2]	8.00– 11.00
Hafnium:	
Sponge, per pound[5]	75.00
Bar and plate, rolled, per pound[5]	120.00
Nitrided, per pound[5]	34.25

NA Not available.
[1] E. I. du Pont de Nemours & Co. Price List. December 1975.
[2] Metals Week, v. 46, No. 52, Dec. 29, 1975, p. 4.
[3] Chemical Marketing Reporter, v. 208, No. 25, Dec. 22, 1975, p. 37.
[4] Ronson Metals Corp. Baddeleyite Price List. Jan. 1, 1976.
[5] American Metal Market, v. 82, No. 255, Dec. 30, 1975, p. 5.

FOREIGN TRADE

Exports of zirconium oxide increased in 1975 over those of 1974, but the exports of zirconium ore and concentrate declined. Exports of all forms of zirconium metal and alloys, in general, rose in 1975.

Zirconium ore and concentrate exported to 13 countries in 1975 decreased from 42,973,250 pounds valued at $3,323,134 in 1974 to 37,531,345 pounds valued at $4,786,799. The quantity exported decreased nearly 13% below that shipped in 1974, but the value rose over 44%. The 1975 value was an alltime high. The average value of the zirconium ore and concentrate exported in 1975 was $255.08 per ton; the 1974 value was $154.66 per ton. This increase was attributed more to the increasing value of zircon than to the larger proportion of higher cost granular and milled zircon shipped. The increase in the proportion of higher cost zircon shipped also indicates a return to the normal zircon-exporting pattern. The major recipients of exported zirconium ore and concentrate were the Netherlands (51%), Mexico (18%), Canada (14%), Brazil (10%), and Spain (5%).

Exports of zirconium oxide increased from 1,816,497 pounds valued at $1,534,010 in 1974 to 2,832,128 pounds valued at $2,905,711 in 1975. Export quantity rose 56% and the value 89% in 1975. These zirconium oxide shipments were made to 21 countries. The six major recipients in 1975 were France (44%), Canada (33%), Brazil and the United Kingdom (4% each), and Italy and Mexico (3% each).

Total exports of other classes of zirconium increased nearly 61%, from 1,650,695 pounds in 1974 to 2,649,694 pounds in 1975. The value of this material rose nearly 42% in 1975 to $25,828,888. Of the categories listed, zirconium and zirconium alloys, wrought, and zirconium and zirconium alloy foil and leaf increased in both value and quantity in 1975. The zirconium and zirconium alloys, unwrought and waste and scrap, decreased in both quantity and value in 1975. The wrought class increased approximately 50% in both pounds exported and in value, and exports of the foil and leaf class increased nearly fifteenfold in quantity and 69% in value. The unwrought and waste and waste and scrap class declined more than 50% in quantity.

Imports for consumption of zirconium ores in 1975 declined to 40,205 short tons, a 36% decrease compared with 62,504 short tons in 1974. The 1974 figure represents the lowest tonnage of ore imported since 1968 (59,900 tons). Zirconium ore imported from the Republic of South Africa is chiefly baddeleyite (ZrO_2) which, prior to 1974, was reported by the Bureau of Census under a separate category listing both quantity and value. This ore is now apparently imported under a blanket category which reports value only. It was estimated that approximately 1,200 short tons of South African baddeleyite was imported in 1975.

The average value of imported zirconium ores, mostly zircon, at foreign ports increased more than twofold in 1975 to $217.81 per short ton compared with $102.36 in 1974.

Imports for consumption of zirconium and hafnium in 1975 increased both in quantity and value in the following categories: Zirconium, wrought; zirconium alloys, unwrought; and zirconium, unwrought and waste and scrap. Imports for consumption decreased in quantity and value in the zirconium oxide category. In the remaining categories, zirconium compounds, n.e.c., and hafnium, wrought, the quantity imported decreased but its value increased.

Table 7.—U.S. exports of zirconium ore and concentrate, by country

Destination	1974		1975	
	Pounds	Value	Pounds	Value
Argentina	223,862	$41,683	253,830	$70,855
Brazil	1,819,260	194,614	3,835,500	647,728
Canada	9,568,114	734,134	5,241,872	864,061
Chile	108,000	38,947	--	--
Germany, West	--	--	3,204	1,906
Greece	2,000	750	--	--
Guyana	--	--	38,803	700
Ireland	84,000	5,696	--	--
Israel	--	--	29,893	7,300
Italy	194,651	39,324	120,000	20,520
Jamaica	68,840	4,840	--	--
Korea, Republic of	200,000	29,212	--	--
Mexico	10,398,300	1,107,492	6,839,127	1,025,547
Netherlands	17,986,858	820,487	18,999,028	1,888,890
Peru	110,000	9,540	55,100	12,810
Spain	1,347,578	238,005	1,760,000	214,400
Taiwan	--	--	53,651	4,970
United Kingdom	861,787	58,410	301,337	27,092
Total	42,973,250	3,323,134	37,531,345	4,786,779

Table 8:—U.S. exports of zirconium oxide, by country

Country	1974		1975	
	Pounds	Value	Pounds	Value
Argentina	99,488	$85,699	48,523	$54,385
Australia	1,779	1,462	1,493	1,000
Belgium-Luxembourg	10,158	9,085	5,580	6,839
Brazil	234,187	199,267	122,000	129,876
Canada	244,100	168,450	933,608	634,349
Chile	1,250	1,850	--	--
Colombia	2,387	2,008	--	--
Dominican Republic	--	--	400	750
France	236,740	241,479	1,232,173	1,561,435
Germany, West	146,612	143,559	40,593	49,357
Greece	1,000	1,129	--	--
Hong Kong	3,000	3,000	--	--
Israel	1,000	1,269	5,299	4,712
Italy	77,605	62,268	96,579	120,707
Japan	139,106	97,799	47,450	52,819
Mexico	287,608	230,462	97,784	95,641
Netherlands	121,254	98,665	56,487	72,451
Peru	2,649	1,775	--	--
Saudi Arabia	--	--	1,000	1,500
South Africa, Republic of	2,042	1,780	94	782
Surinam	--	--	618	1,500
Sweden	23,362	15,921	23,520	22,167
Switzerland	--	--	200	1,476
Taiwan	8,000	7,280	250	1,200
United Kingdom	172,170	159,063	118,043	92,165
Venezuela	1,000	740	434	600
Total	1,816,497	1,534,010	2,832,128	2,905,711

Table 9.—U.S. exports of zirconium by class and country

Country	1974		1975	
	Pounds	Value	Pounds	Value
Zirconium and zirconium alloys, wrought:				
Argentina	435	$14,061	--	--
Australia	--	--	190	$2,610
Belgium-Luxembourg	51,653	1,677,740	74,596	2,437,337
Brazil	150	4,875	3,485	3,788
Canada	220,771	3,607,828	510,568	8,149,651
France	7,661	84,576	1,591	23,440
Germany, West	394,815	3,592,618	439,237	5,003,535
Ireland	[r] 390	[r] 2,040	--	--
Israel	[r] 2,156	[r] 8,892	--	--
Italy	53,584	2,077,837	3,518	218,863
Japan	171,261	3,235,385	190,252	4,107,343
Korea, Republic of	--	--	60	1,017
Mexico	200	1,664	--	--
Netherlands	16,005	156,217	106,200	846,936
Norway	9,103	83,981	2,285	46,347
Portugal	460	7,098	60	1,450
Romania	633	8,329	--	--
South Africa, Republic of	--	--	1,621	14,819
Spain	156	1,237	--	--
Sweden	43,627	312,166	153,508	1,231,877
United Kingdom	112,378	730,324	106,482	999,011
Total	1,085,438	15,606,841	1,593,653	23,088,024
Zirconium and zirconium alloys, unwrought and waste and scrap:				
Argentina	--	--	2,025	14,900
Belgium-Luxembourg	--	--	1,218	5,518
Brazil	88	900	44	1,580
Canada	16,165	254,728	12,347	187,192
Ecuador	--	--	11	2,250
France	4,730	14,206	58,375	273,268
Germany, West	26,545	173,094	53,907	349,321
Indonesia	--	--	3,042	7,747
Israel	237	13,446	--	--

See footnotes at end of table.

Table 9.—U.S. exports of zirconium by class and country—Continued

Country	1974		1975	
	Pounds	Value	Pounds	Value
Zirconium and zirconium alloys, unwrought and waste and scrap—Continued				
Jamaica	254	$1,140	--	--
Japan	250,741	347,163	52,225	$209,146
Mexico	140	882	160	1,200
Norway	618	2,769	558	7,034
South Africa, Republic of	--	--	506	3,006
Sweden	104,603	547,529	23,854	316,301
United Kingdom	107,213	582,100	43,129	261,966
Total	511,334	1,937,957	251,402	1,640,429
Zirconium and zirconium alloy foil and leaf:				
Belgium-Luxembourg	3,714	50,394	4,374	82,488
Canada	18,870	325,814	12,864	208,529
Colombia	28	530	--	--
France	88	704	--	--
Germany, West	2,842	40,347	3,912	22,083
Ireland	--	--	133	4,853
Israel	123	1,468	--	--
Italy	6,684	121,317	2,243	48,490
Japan	4,983	12,850	[1]773,184	[1]651,863
Netherlands	--	--	4,509	17,134
Sweden	15,133	70,368	--	--
United Kingdom	1,458	26,406	3,420	64,995
Total	53,923	650,198	804,639	1,100,435

[r] Revised.
[1] As reported by Bureau of the Census. Quantity and value questionable.

Table 10.—U.S. imports for consumption of zirconium ores, by country

Country	1973		1974		1975	
	Quantity (short tons)	Value thousands)	Quantity (short tons)	Value thousands)	Quantity (short tons)	Value thousands)
Australia	90,353	$4,747	59,747	$6,031	36,114	$7,602
Austria [1]	1	(2)	--	--	--	--
Canada [1]	1,179	82	1,054	90	377	61
India	--	--	--	--	2,756	894
Malaysia	445	15	1,142	188	440	82
Mozambique	--	--	--	--	22	10
South Africa, Republic of	1,019	394	7	1	496	225
Thailand	--	--	554	88	--	--
United Kingdom [1]	5,003	175	--	--	--	--
Venezuela	23	2	--	--	--	--
Total	98,023	5,415	62,504	6,398	40,205	8,874

[1] Believed to be country of shipment rather than country of origin.
[2] Less than 1/2 unit.

Table 11.—U.S. imports for consumption of zirconium and hafnium[1] in 1975

Country	Pounds	Value
Zirconium wrought:		
Canada	4,778	$41,336
France	152,880	1,364,947
Germany, West	26	1,156
Total	157,684	1,407,439
Zirconium unwrought, and waste and scrap:		
Canada	38,281	94,149
France	5,448	2,605
Germany, West	176,452	293,292
Japan	467,587	1,878,530
Sweden	15,943	29,284
United Kingdom	47,438	52,755
Total	751,149	2,350,615
Zirconium alloys, unwrought:		
Canada	2,800	1,080
France	2,332	29,996
Germany, West	100	1,250
Total	5,232	32,326
Zirconium oxide:		
Germany, West	68	5,717
Switzerland	253	5,452
U.S.S.R	66,139	81,245
United Kingdom	141,589	132,994
Total	208,049	225,408
Zirconium compounds, n.e.c.:		
Australia	166,913	25,948
Canada	5,914	9,228
France	115,357	73,131
Germany, West	1,488	20,242
Netherlands	2,789	7,873
South Africa, Republic of	66,138	9,424
Switzerland	443	945
United Kingdom	2,542,909	1,829,656
Total	2,901,951	1,976,447
Hafnium, wrought: Barbados	74	16,189

[1] Hafnium unwrought and waste and scrap—none.

WORLD REVIEW

Australia leads the world in production of zircon, which is recovered from sand-mining operations along the eastern coast (75%) and in Western Australia (25%). Production of zircon, a coproduct of rutile in the East, is expected to remain relatively constant due to lower grades and reserves coupled with persistent environmental problems. However, substantial zircon reserves with coproduct ilmenite have been located in Western Australia which, when fully developed, will assure Australia's continuing role in the world zircon markets.[7]

Zircon sand is also produced in Brazil, the People's Republic of China, India, Malaysia, the Republic of South Africa, Spain, Sri Lanka, Thailand, the Republic of Korea, and the U.S.S.R.

Baddeleyite is produced in the Republic of South Africa and Brazil; it is also found in east Africa, Sri Lanka, and the U.S.S.R.

[7] Industrial Minerals (London). A Guide to the Mineral Sands Industry of Western Australia. No. 98, November 1975, pp. 43–46.

Table 12.—Zirconium concentrate: World production by country [1]
(Short tons)

Country	1973	1974	1975 p
Australia	393,336	406,648	421,314
Brazil	3,411	e 3,500	e 3,500
India	[2] 11,311	r e 11,400	e 11,400
Korea, Republic of	25	44	e 44
Malaysia [3]	3,463	3,035	e 3,000
South Africa, Republic of	5,463	16,330	12,780
Sri Lanka	31	23	e 20
Thailand	443	2,207	422
United States	W	W	W
Total	r 417,483	443,187	452,480

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] No data are available on production, if any, within the centrally-planned economy nations, nor is there any basis for the formulation of reliable estimates of output levels.
[2] Data is for fiscal year April 1, 1972, through March 31, 1973.
[3] Exports (production not officially reported; exports believed to closely approximate total output).

Argentina.—A Zircaloy tubing fabrication plant, being built in cooperation with the Canadian Government, was scheduled for operation in 1981 by Argentina's Comisión Nacional de Energía Atómica (CNEA).[8]

Australia.—A feasibility study for the country's first zirconia plant was being considered by Ionarc Smelters Ltd. of Vancouver, British Columbia, for Associated Minerals Consolidated Ltd. (AMC), a subsidiary of Consolidated Gold Fields Australia, Ltd. Ionarc uses a novel plasma, melting-leaching technique in its process for recovering the oxide. Zircon sand from existing leases was planned as feed for the plant. A decision on the new plant is expected early in 1976.[9] AMC also commissioned its new opacifier plant at Southport, 45 miles north of Brisbane. The plant was scheduled to grind zircon from the company's Dunwich operation on North Stradbroke Island. AMC was also working with the Australian steel industry and the Commonwealth Scientific and Industrial Research Organization (CSIRO) in developing and successfully testing a zircon ladle refractory for industrywide use.[10]

Mineral Deposits Ltd. (MDL) announced plans for starting up a 20,000- to 30,000-ton-per-year mineral sands operation, including zircon, at Agnes Water in central Queensland. Reserves were reported adequate for about 12 years at the announced rate.[11] MDL relocated its largest sand mining plant from Tuncarry to Bridge Hill Ridge North. The mineral sands plant, capable of processing over 1,500 tons per hour, was moved because of the New South Wales Government decision to allow mining only the northern section of the granted leases at Bridge Hill Ridge. The prohibition reduced the company's rutile and zircon reserves by 20% each. Reserves in 1974 were reported to be in excess of 1 million tons each.[12]

The beach sand mining project operated by D. M. Minerals, a joint venture owned by Dillingham Mining Co. of Australia Ltd. and Murphyores Holdings, Ltd., has started off the coast of Queensland on Fraser Island. The processing plant at nearby Maryborough, on the mainland, was almost complete. To date, approximately $10 million has been spent on development.[13]

Ferroalloy production, including ferrosilicon zirconium, was discontinued at the Broken Hill Pty. Co. Ltd. plant in Newcastle, New South Wales.[14] The plant was commissioned as a wartime measure in 1940.

Du Pont (Australia) Ltd. and Allied Minerals NL, partners in Allied Eneabba

[8] Engineering and Mining Journal. This Month in Mining—Brazil and Argentina Take Giant Steps Towards Nuclear Self-Sufficiency. V. 176, No. 8, August 1975, p. 23.
[9] Chemical Engineering. CPI News Briefs—Plants. V. 82, No. 23, 1976, p. 68.
[10] Gadsden, P. D. H. Zirconium and Hafnium. Min. Ann. Rev. 1976, (London), June 1976, p. 95.
[11] Industrial Minerals (London). Company News & Mineral Notes. No. 93, June 1975, p. 49.
[12] Engineering and Mining Journal. This Month in Mining—Australia. V. 176, No. 10, October 1975, p. 171.
[13] Mining Magazine (London). Highlights—International News: Australasia. V. 132, No. 2, February 1975, p. 120.
[14] Metals Source Book. Ferrous Metals. V. 3, No. 7, April 1975, p. 4.

Pty. Ltd., estimated their heavy-mineral reserves at 7.75 million tons of proven material and 27.75 million tons of probable ore. This $13.2 million beach sand project reached production stage in July.[15] The Jennings Mining Ltd., heavy mineral sands operation, also in Eneabba, about 180 miles north of Perth, reached design capacity during September.[16]

The Westralian Sands Ltd. proposed beach sand operation at Gingin was deferred along with the decision to establish an ilmenite beneficiation plant.[17] Western Mining Corp. Ltd. (WMC) bought all outstanding shares of Black Sands Ltd. (BSL), which owns deposits of heavy mineral sands north of Perth. In addition to $A5.15 million for the shares, $A3.62 million was allocated to repay money already spent on development work. An expected $A4.6 million was to be spent on further development. The Jurien deposits of BSL are said to contain 3.2 million tons of heavy minerals, including zircon, ilmenite, and rutile.[18]

A $22 million contract was awarded to Fluor Australia Pty. Ltd., a subsidiary of Fluor Corp., for engineering, procurement, and construction management of the Eneabba mineral sands project in Western Australia for Western Titanium Ltd., a subsidiary of Consolidated Gold Fields Australia Ltd. The project includes a mining facility with feed preparation, and wet and dry processing at Eneabba's port facility at Leeman. The dredging rate for the zircon, rutile, leucoxene, and ilmenite ore feed was under 700 tons per hour.[19]

Canada.—Norco Industries Ltd. started constructing its previously announced tube mill plant at Armprior, Ontario, to extrude zirconium alloy for fuel sheathing, zirconium alloy pressure tubes, and nickel and titanium alloys, as well as heat-exchange tubing. Production of nuclear-grade industrial tubing and zirconium alloys was scheduled for early 1976. Teledyne Wah Chang, Albany, Oreg., was to be the major supplier of the required zirconium alloys.[20] There currently is no commercial production of either zircon or zirconium alloys in Canada.

A promising source of future Canadian zircon was reputed to be the Athabasca tar sands currently being processed by Great Canadian Oil Sands (GCOS). The clean sands, high in zircon, in connection with the GCOS oil recovery program could supply up to 20,000 tons per year.[21]

Gambia.—A study to determine the technical, financial and economic feasibility of recovering zircon, ilmenite, and rutile from the mineral sands in the Brufut and other areas was being carried out for the Ministry of Economic Planning and Industrial Development by Matthew Hall Ortech of the United Kingdom.[22]

India.—Kerala Minerals and Metals Ltd. (KMM) Quilon, a heavy mineral sands producer on the Malabar Coast of the Arabian Sea, was involved in expanding its activities to include marketing refined mineral and chemical derivatives. The three-phase expansion program included a titania, titanium sponge, and zirconium chemicals plant.[23] A large, heavy-mineral sand deposit has been found in a 16-mile belt in the coastal areas of Ganjam and Puri districts in Orissa State on the Bay of Bengal, south of Calcutta, according to the Minister for Mining and Geology. The State Government had previously leased the deposit to Indian Rare Earths Ltd., a subsidiary of the Atomic Energy Commission of India.[24]

Malagasy, Republic of.—An Italian company, Montecatini Edison S.p.A., and United States Steel Corp. progressed on their exploration programs on the east coast for locating zircon and ilmenite deposits. Pilot plants were set up to determine the feasibility of commercial-scale production.[25]

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15 Mining Magazine (London). Highlights–Australasia. V. 132, No. 6, June 1975, pp. 455–456.
16 Engineering and Mining Journal. This Month in Mining–In the Pacific. V. 176, No. 10, October 1975, p. 173.
17 Industrial Minerals (London). World of Minerals. No. 96, September 1975, p. 9.
18 Mining Magazine (London). Highlights–Australasia. V. 132, No. 2, February 1975, p. 147.
19 Mining Engineering. Minerals Industry News–Fluor To Manage Australian Mineral Sands Project Construction. V. 27, No. 11, November 1975, p. 13.
20 Canadian Mining Journal. Canadian Mineral Survey, 1975. V. 97, No. 2, February 1976, p. 121.
21 Flakstad, N. Zirconium Becomes a Nuclear Age Necessity. Northern Miner, v. 61, No. 37, 1975, pp. 1314, 1330.
22 Mining Magazine (London). Highlights–International News: Africa. V. 133, No. 5, November 1975, p. 895.
23 Industrial Minerals (London). No. 99, December 1975, p. 10.
24 Engineering and Mining Journal. This Month in Mining: In the Pacific–India. V. 177, No. 5, May 1976, p. 180.
25 Mining Journal (London). Mining Annual Review, 1976. Central Africa–Malagasy Republic. June 1976, pp. 445–446.

Malaysia.—Trial runs for a new heavy-sand beneficiation plant near Ipoh, Perak, for the first half of 1976 was announced by Malaysian Trading, held by Straits Trading (30%) and two other Malay interests. Zircon production goals were not specified.[26]

Mauritania.—Proposed mining research for 1975–80, published by the Office of Mines and Geology, included heavy-mineral sandstone deposits in the south and in unspecified beach and dune zones.[27]

Mozambique.—The West German Institute of Geoscience and Raw Materials reported the discovery of an estimated 30 million tons of ilmenite, 2 million tons of rutile, and 3 million tons of zircon offshore under 98 to 165 feet of water. Preussag AG, a member of the West German AMR ocean mining group, was believed to have applied for a concession to explore the discovery.[28]

Peru.—A new mining company, Amautas Inc., working closely with the Government agency, Minero Perú, was studying the recovery of zircon, high-grade magnetite, and rutile from a stretch of beach sands in the north. The heavy minerals, intended for both local and international markets in 1976, were scheduled for export from the nearby ports of Paita and Talara.[29]

Philippines.—French interests have located large underwater placers of zirconiferous sand on the continental shelves.[30]

Senegal.—Tests conducted on beach sand samples from the coastal areas south of Dakar by the Ore Dressing Laboratory at Liége University in Belgium have yielded commercially promising zircon and titanium mineral concentrates.[31]

Sierra Leone.—Construction of a pilot plant, scheduled for completion in 1976, was announced by the Bayer-Preussag Mining group. The new group is essentially taking over where Sherbo Minerals Co. Ltd. ceased operating at Bonthe and Moyamba in 1971. Performance of the pilot plant, partially financed by the West German Government, will help determine whether the group, jointly owned by the Bayer Chemical Co. and Preussag, will commission a large-scale heavy-mineral separation plant.[32]

South Africa, Republic of.—The Richards Bay beach sand mining operation by Tisand Pty. Ltd., pending financial arrangements, was tentatively scheduled for operation by yearend 1977. Richards Bay Iron and Titanium Ltd. (RBIT) was responsible for titanium slag production. Tisand was backed by Union Corp. and Industrial Development Corp. (IDC); RBIT was backed by the Kennecott subsidiary, Quebec Iron and Titanium Corp. (QIT). Equity in the operating companies was Union Corp. (25%), IDC (25%), and QIT (50%).

Dredging capacity at Richards Bay was rated up to 96,000 tons per day with the annual production of over 150,000 tons of zircon. The company was planning to use Australian beach area reclamation consultants for guidance.[33]

Baddeleyite concentrates were produced at Phalaborwa, South Africa by Phosphate Development Corp. Ltd. (FOSKOR) and by Palabora Mining Co. Ltd. (PMC) mining contiguous deposits in the Palabora igneous complex. These baddeleyite concentrates, coproducts of copper, phosphate, and iron operations, pure (97% + ZrO_2) and ultrapure (99+%), were favorably received by the abrasive, ceramics, and refractory industries. Plant expansions are presently underway at both locations. In addition, PMC was producing and marketing an acid zirconium sulfate containing 33.1% ZrO_2.[34]

Spain.—Two new zircon grinding and opacifier plants were under construction and due for completion in 1976. Associated Lead Manufacturers' (ALM) plant is at Valencia and Vicor Quimia S.A.'s plant is at Tarragona. The latter plant has a capacity of 17,000 short tons per year.[35]

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[26] Metals Sourcebook. Light Metals. V. 3, No. 11, June 16, 1975, p. 4.
[27] U.S. Embassy, Nouakchott, Mauritania. State Department Airgram A-64, Oct. 2, 1975, 2 pp.
[28] Work cited in footnote 26.
[29] Iron and Steel Engineer. Editor's Notes. V. 52, No. 4, April 1975, p. 33.
[30] Mining Magazine (London). World Digest—French Interest in Offshore. V. 133, No. 4, October 1975, pp. 327–328.
[31] Mining Magazine (London). World Digest—Beneficiation of Senegal Beach Sands. V. 132, No. 4, April 1975, pp. 323.
[32] Engineering and Mining Journal. This Month in Mining: In Africa—Sierra Leone. V. 176, No. 17, November 1975, p. 256.
[33] Mining Magazine (London). Panorama—International News: Go-Ahead Announced for South African Beach Sands Project at Richards Bay. V. 133, No. 6, December 1975, p. 421.
[34] Mining Magazine (London). Expansion Programme at Palabora. V. 132, No. 6, June 1975, pp. 440–443.
[35] Industrial Minerals (London). Company/Mineral News. No. 99, December 1975, p. 60.

Sri Lanka.—An expansion program was begun by Mineral Sands Corp. of Sri Lanka, a producer of ilmenite and rutile, to include zircon-recovery circuits. The program also involved moving operations from China Bay, Trincomalee, to Pulmoddai where work has already started on the new mineral sands plant. This plant is due to come onstream by 1980.[36]

Yemen, People's Democratic Republic.—A recently completed survey oulined large reserves of zircon and titanium-bearing minerals in the beach sands in the Maabir-Gaabar area southwest of the port of Mukalla.[37]

TECHNOLOGY

Bureau of Mines research efforts were directed toward using zircon as mold material for metal casting, electrolytic preparation of zirconium and hafnium diborides, advanced zirconium alloys, and an electron microprobe study of commercially available zircons. Preliminary tests on a shell-casting process for titanium indicate the potential use of zircon sand and waterglass binder. Results on molybdenum casting have shown that molds of suitable strength can be made by using zirconium and aluminum oxides bound with zirconium acetate and fired in either air or hydrogen. In the electrolytic research, zirconium and hafnium diborides of approximately 98% purity were electrodeposited from their respective oxides dissolved in borate-cryolite-carbonate electrolytes at 1,050° C.[38] Zirconium diboride was also deposited from an electrolyte prepared with zircon sand. Microprobe studies on zircon revealed that an appreciable portion of the yttrium, rare earth, and phosphorus are in solid solution, and only a part of these impurities could be removed from these concentrates by mineral-dressing techniques.[39] Magnetic zircon grains contained considerably more yttrium and phosphorus, presumably as a xenotime (YPO_4) solid solution, and frequently bore xenotime and apatite precipitates or inclusions. Continuous chlorination of zircon in the initial step of zirconium sponge production has resulted in the deleterious carryover of rare earth and phosphorus impurities. The rare earths adversely affect the thermal neutron cross section and phosphorus lowers the corrosion resistance of the fabricated zirconium product. Initial Bureau testing on advanced alloys demonstrated that a commercial magnesium-zirconium alloy displayed superplastic behavior under certain combinations of microstructure, temperature, and strain rate. Superplasticity or exaggerated ductility could conceivably permit the solid-state injection molding of intricate shapes. In other work, the creep behavior of a tungsten alloy strengthened by a ZrO_2 dispersoid was studied over a range of temperature and stress conditions.[40] A "sandwich panel" developed by Bureau metallurgists has promise in turning more of the sun's rays into heat for making steam.[41] The panel consists of zirconium sputtered in thin layers on copper and silver and then chemically converted to zirconium oxide or nitride. Zirconium subnitride on silver was the most effective combination in absorbing the rays and converting them into heat. The silver or a copper backing carries the heat away by conduction for use in making steam for electric power and other purposes.

A report on the heavy mineral placers in the southeastern Atlantic States, with particular emphasis on the general geology of the Piedmont and Coastal Plain Provinces, along with a detailed description of past and present placer mines in South Carolina, Florida, and Georgia was published.[42] The mineralogy of the potentially valuable zirconiferous beach sands near Cox's Bazar, about 62 miles south of

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36 Mining Magazine (London). Highlights-International News: Sri Lanka Project. V. 133, No. 6, December 1975, p. 485.

37 Industrial Minerals (London). Company News and Mineral Notes. No. 96, September 1975, p. 53.

38 Gomes, J. M., K. Uchida, and M. M. Wong. Electrolytic Preparation of Titanium and Zirconium Diborides From Their Oxides and Mineral Concentrates. BuMines RI 8053, 1975, 14 pp.

39 Romans, P. A., L. L. Brown, and J. C. White. An Electron Microprobe Study of Yttrium, Rare Earth, and Phosphorus Distribution in Zoned & Ordinary Zircon. Am. Miner., v. 60, Nos. 5–6, May–June 1975, pp. 475–480.

40 Blickensderfer, R. Creep Behavior of Tungsten Alloy Dispersion Strengthened by ZrO_2. Met. Trans., v. 5, No. 11, November 1975, pp. 2347–2350.

41 U.S. Bureau of Mines. Mines Bureau Develops Promising Metal Combinations for Using Solar Power. Press Release, Oct. 6, 1975, 1 p.

42 Mertie, J. B., Jr. Monazite Placers in the Southeastern Atlantic States. U.S. Geol. Survey Bull. 1390, 1975, 41 pp.

Chittagong on the southern coast of Bangladesh, was discussed.[43] A report on the Eneabba deposits of western Australia operated by Jennings Mining Ltd., its dry and wet mills, their capacities, and marketing plans were outlined.[44] Present and future supply-demand technical relationships for zircon and South African baddeleyite were documented.[45] Predictions of a zircon oversupply and a fall in prices were presented. The prediction was based on the substitution of alternative foundry and refractory materials, such as chromite and olivine. Another work also predicted technologic trends resulting in changes of zircon supply and demand patterns for the middle 1970's.[46]

An improved method was patented for beneficiating oxide ores, such as baddeleyite, by froth flotation.[47] The improved process requires conditioning the comminuted ore slurry with an inorganic peroxyacid or their alkali or ammonium salts, followed by an effective amount of a collector/frother of an alkyl-olefin adduct of glycerol-type compound. Another patent now enables chrome fungicidal mineral dyeing from a single zirconyl acetate system, without the need for an alkali.[48] Previously, separate baths were required to deposit the dye and fungicide on cellulosics. A new additive system for quicker drying alkyd coatings, based on a low acid calcium primary dryer and a cobalt-zirconium auxiliary dryer, was announced.[49] A depletion of zirconium was noted in fly ashes downstream from mechanical collectors.[50] This depletion was attributed to the occurrence of zircon, the source of zirconium in coals, which does not combine readily with lithophile minerals and melts at a very high temperature. The high melting point would preclude glassy sphere formation during coal burning which comprises the bulk of fly ash. In addition, zircon has a higher specific gravity (4.6) than fly ash (—2.5) and is resistant to mechanical breakage. A similar study of some Belgian coals and ashes, analyzed for 44 elements using a combination activation analysis with thermal and 14-MeV neutrons, was also published.[51] A method for the spectrophotometric determination of hafnium in the presence of zirconium was developed.[52] This method is one of few known that permits the ready determination of hafnium in the presence of zirconium.

A highly accurate method for monitoring water vapor concentration in a hydrogen atmosphere or trace amounts of hydrogen in water vapor is now possible with a newly developed solid stabilized zirconia electrolyte technique.[53] The new method is based on a commercially available zirconia tube with one closed end. The closed end protrudes into the atmosphere being measured, heated from 500° to 600° C, and monitors the gas as it is passed over the hot tube. The new system easily measures from several parts per million to several parts per 100 million. Lanthanum-doped lead zirconate-titanate ceramics (PLZT) and similar materials (Pb, La, Hf, Ti, O_3) that have potential for electrooptic applications because of their high transparency and good electrooptic characteristics, can now be fabricated.[54] The new fabrication method uses ferroelectric materials with small anisotropy to insure highly transparent ceramics. The anisotropy of these materials was further controlled during hot-pressing by changing the Sr- or Ba-doping concentrations. The influence of grain size on the optical prop-

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[43] Hassain, A. The Occurrence of Polyframboidal Pyrite in a Beach Sand Deposit, Cox's Bazar, Bangladesh. Am. Miner., v. 60, Nos. 1–2, January–February 1975, pp. 157–158.

[44] Industrial Minerals (London). Jennings Mining: First Into Full Production at Eneabba. No. 98, November 1975, pp. 39–41.

[45] Industrial Minerals (London). Zircon: Towards Oversupply Again? No. 91, April 1975, pp. 34–43.

[46] Van Gordon, D. V., and R. E. Collins. Mid-1970's Imbalance in Zircon Supply and Demand. Bull. Am. Ceram. Soc., v. 59, No. 9, September 1975, pp. 801–802.

[47] Petrovich, V. Froth Flotation Method for Recovery of Minerals. U.S. Pat. 3,923,647, Dec. 2, 1975.

[48] Conner, C. J. Single Bath Chrome-Zirconyl Acetate Mineral Dyeing Process for Cellulosics. U.S. Pat. 3,917,466, Nov. 4, 1975.

[49] Chemical Week. Specialties: They'll Take Down the "Wet Paint" Sign Sooner. V. 117, No. 22, Nov. 26, 1975, pp. 21–22.

[50] Kaakinen, J. W., R. M. Jorden, M. H. Lawasani, and R. E. West. Trace Element Behavior in Coal-Fired Power Plant. Environ. Sci. and Technol., v. 9, No. 9, September 1975, pp. 785–892.

[51] Block, C., and R. Dams. Inorganic Composition of Belgian Coals and Coal Ashes. Environ. Sci. and Technol., v. 9, No. 2, February 1975, pp. 146–150.

[52] Subramanyam, B., and M. C. Eshwar. Rapid Spectrophotometric Determination of Hafnium (IV) With 4-(2-Pyridylazo) Resorcinol. Anal. Chem., v. 47, No. 9, August 1975, pp. 1692–1693.

[53] Industrial Research. Chemistry: Zirconia Monitors Hydrogen Impurities. V. 17, No. 2, February 1975, pp. 36–37.

[54] Miyauchi, K., and G. Toda. Transparent Ferroelectric Ba- and Sr-Doped Lead Zirconate-Titanate Ceramics. J. Am. Ceram. Soc., v. 58, Nos. 3–4, March–April 1975, pp. 157–158.

erties of PLZT ceramics were measured and correlated with optical transmission at various wavelengths.[55]

Satisfactory performance of modified PZT piezoelectric ceramic disks was reported for a wide range of hydrostatic pressures and electric fields.[56] The solubility limit of lanthanum in PLZT systems was established in conventionally sintered ceramics by the disappearing-phase technique using X-ray diffractometry.[57] Changes in slope of the lattice constants and stabilization of the Curie temperature were used as independent checks on the disappearing method.

Partially stabilized zirconia (PSZ) products that are both stronger and more resistant to thermal shock than either unstabilized or fully stabilized bodies were found to be superior because of the fine dispersion of zirconia precipitates in the cubic grains.[58] The transmission electron microscopic studies revealed that the useful mechanical properties of PSZ result from the influence of these tetragonal precipitates on crack propagation. The high-temperature creep behavior of yttria-stabilized zirconia (YSZ) was studied at temperatures to 1,200° C under the conditions of stress and environments found in storage heaters in "blow down" wind tunnels.[59] This research is invaluable in predicting the plastic deformation of YSZ which is related to its structural integrity, during the operation of storage heaters. The anticipated useful and unique plastic behavior of hot-working ZrO_2 during its monoclinic-to-tetragonal inversion was not realized.[60] Although this behavior did not occur, light was indeed shed on the phenomenon of "transformational plasticity" in ZrO_2.

A reexamination of ternary system CaO–ThO_2–ZrO_2, using induction plasma torch techniques, discovered a new pyrochlore-type compound with the approximate composition of 2 CaO–2ThO_2–5ZrO_2.[61] Phase equilibria in the yttria-hafnia system were investigated by high-temperature and room-temperature X-ray diffractometry.[62] The HfO_2 transformation, solid solution limits, liquidus temperatures, and a tentative phase diagram were advanced. Hafnia is a promising refractory material. Success was also noted with ZrO_2 ZrN, and ZrC additives. The effects of impurities on these mechanisms are presently being investigated.

Zirconium alloy oxidation was attributed to a cubic rate law, but the actual kinetics depended on the exact relationship between grain diameter and film thickness.[63] The diffusion of oxygen in zirconium was determined by nuclear microanalysis techniques.[64] A unique profile of the oxide penetration was readily apparent.

Studies on ternary molybdenum-based alloys, some of which contain hafnium as the hardening agent, showed that this hardness behavior can be anticipated from binary data with an expression involving the number of s + d electrons contributed by the solute elements.[65] If this argument is valid, it should be possible to simply predict the hardness behavior of ternary alloys. An alternative expression explaining alloy softening was also offered.

Steel pipes capable of handling molten metal were manufactured by protecting them with a layer of zirconium nitride.[66]

Materials for nuclear power systems, in-

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[55] Matsuyama, I., and S. Jyomura. Grain Dependence of Optical Transmission in 7.6/70/30/ PLZT. J. Am. Ceram. Soc., v. 58, Nos. 7–8, July–August 1975, pp. 347–348.

[56] Wilhelm, R. V., Jr., and M. G. McLaren. Effects of Hydrostatic Pressure and High Electric Field on Modified PZT Piezoelectric Ceramics. Bull. Am. Ceram. Soc., v. 75, No. 8, August 1975, pp. 714–724.

[57] Schulze, W. A., T. G. Miller, and J. V. Biggers. Solubility Limit of La in the Lead Zirconate-Titanate System. J. Am. Ceram. Soc., v. 58, Nos. 1–2, January–February 1975, pp. 21–23.

[58] Bansal, G. K., and A. H. Heuer. Precipitation in Partially Stabilized Zirconia. J. Am. Ceram. Soc., v. 58, Nos. 5–6, May–June, 1975, pp. 235–238.

[59] Seltzer, M. S., and P. K. Talty. High-Temperature Creep of Y_2O_3–Stabilized ZrO_2. J. Am. Ceram. Soc. v. 58, Nos. 3–4, March–April 1975, pp. 124–130.

[60] Bansal, G. K., and A. H. Heuer. Transformational Hot-Working of ZrO_2 Polycrystals. J. Am. Ceram. Soc., v. 58, Nos. 1–2, January–February 1975, pp. 76–77.

[61] Rhoeder, E. W. F., and H. J. C. Wilson. The System CaO–ThO_2–ZrO_2. J. Am. Ceram. Soc., v. 58, Nos. 5–6, May–June 1975, pp. 161–163.

[62] Stacy, D. W., and D. R. Wilder. The Yttria-Hafnia System. J. Am. Ceram. Soc., v. 58, Nos. 7–8, July–August 1975, pp. 285–288.

[63] Sabol, G. P., and S. B. Dalgaard. The Origin of the Cubic Rate Law in Zirconium Alloy Oxidation. J. Electrochem. Soc.: Solid-State Sci. & Technol., v. 122, No. 2, February 1975, pp. 316–317.

[64] J. David, D. G. Amsel, P. Boisot, and G. Berenger. Title A Study of the Diffusion of Oxygen in Alpha-Zirconium by Means of Nuclear Microanalysis. J. Electrochem. Soc.: Solid-State Sci. and Technol., v. 122, No. 3, March 1975, pp. 388–396.

[65] Stephens, J. R., and W. R. Witzke. The Role of Electron Concentration in Softening and Hardening of Ternary Molybdenum Alloys. J. Less-Common Metals, v. 41, No. 2, July 1975, pp. 265–282.

[66] Industry Week. Emerging Technologies. V. 186, No. 7, Aug. 18, 1975, p. 23.

cluding zirconium alloys, were listed in a guide planned for use in various commercial and development systems.[67]

Porous platinum layers formed on the inner and outer surfaces of ceramics, such as zirconia, serve as electrodes and also perform a catalytic function. However, the nonadherence of the platinum layers after exposure to reducing atmospheres at high temperatures has limited its applicability.[68] This debonding or nonadherence was attributed to the reaction between platinum and the zirconia, which form either solid solutions or intermetallic compounds. This mechanism was also observed for the cubic stabilizer as well as for the SiO_2 impurity present in ZrO_2. A grain stabilized zirconia product with platinum was experiencing increased use as a replacement for platinum and its alloys in high-temperature service in oxidizing atmospheres.[69] Preliminary research was successful on hot-pressing Si_3N_4 using zirconium-bearing additives such as zircon to promote densification and form a more refractory silicate grain-boundry phase, thereby improving high-temperature strength.[70]

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[67] Vaccari, J. A. Materials for Nuclear Power Systems. Mater. Eng., v. 81, No. 4, April 1975, pp. 18–25.

[68] Rhee, S. K. ZrO_2-Pt Interface Reactions. J. Am. Ceram. Soc., v. 58, November–December 1975, pp. 11–12.

[69] Ceramic Industry. Ceramic Industry Newsletter–Grain Stabilized Platinum Broadens Design Horizons. V. 105, No. 4, October 1975.

[70] Rice. R. W., and W. J. McDonough. Hot-Pressed Si_3N_4 With Zr-Based Additions. J. Am. Ceram. Soc., v. 58, Nos. 5–6, May–June 1975, p. 264.

Minor Metals

By Staff, Division of Nonferrous Metals

CONTENTS

ARSENIC [1]

Legislation and Government Programs.—The Occupational Safety and Health Administration (OSHA) held public hearings in early 1975 on proposed standards for exposure to inorganic arsenic. The findings obtained at the hearings will be considered to promulgate emission standards.

Domestic Production.—Arsenic trioxide (As_2O_3) was produced domestically only at the Tacoma, Wash. copper smelter of ASARCO Incorporated. Production data cannot be published. Output rose 9% over that of 1974, shipments were less than half those of 1974, and stocks rose 31%. Production of arsenic metal, begun by ASARCO in August 1974, continued in 1975.

Consumption and Uses.—Apparent consumption of arsenic, essentially all as white arsenic (As_2O_3), was substantially lower than that used in 1974. Data for calcium and lead arsenate, historically the principal end products, cannot be published.

The use of chromated copper arsenate (CCA compounds) in wood preservatives increased for the seventh consecutive year; 7,629 tons, 31% more than that in 1973, was consumed in 1974. Consumption of fluor chrome arsenate phenol (Wolman salts and osmosalts continued downward; 758 tons was consumed in 1974 compared with 842 tons in 1973.

Small quantities of high-purity arsenic were used in the manufacture of gallium and indium arsenides for semiconductors.

Prices.—The price of refined white arsenic, 99.5%, at New York docks, was quoted at 20 to 23 cents per pound throughout 1975. Refined white arsenic at Laredo was raised from $210 per ton at yearend 1974, to $300 per ton in early January 1975, and to $330 per ton on September 18. The price of arsenic metal at Tacoma was quoted at $3,200 per ton throughout 1975.

Arsenic metal was quoted in London at £1,500 to £2,000 per metric ton until May 7 when it rose to £2,175 per metric ton where it remained throughout 1975.

Foreign Trade.—Imports of white arsenic dropped 13% from those of 1974 and were the lowest since 1960. Sweden remained the principal supplier accounting for 60% of the total receipts. Mexico provided 26%, South West Africa 8%, France 5%, and the remainder came from West Germany, Peru, and Switzerland. All of the arsenic acid (26 pounds)came from Belgium-Luxembourg, 52 pounds of arsenic sulfide was received from the United Kingdom, and 1,323 pounds of sodium arsenate came from West Germany. Of the 152,496 pounds of other arsenic com-

[1] Prepared by Gertrude N. Greenspoon, mineral specialist.

pounds imported in 1975, 111,146 pounds came from the United Kingdom, 40,807 pounds came from Switzerland, 536 pounds came from West Germany, and several pounds each came from Belgium-Luxembourg and Japan.

Arsenic metal imports totaled 483 tons, 32% less than those of 1974. Sweden supplied 463 tons, Canada 18 tons, and West Germany and Japan each 1 ton. Smaller quantities were received from the United Kingdom, the Netherlands, and Belgium-Luxembourg.

Table 1.—U.S. imports for consumption of white arsenic (As_2O_3) content, by country

Country	1973		1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	21	$3	--	--	--	--
France	1,281	190	480	$90	595	$261
Germany, West	11	4	--	--	6	5
Mexico	5,605	760	6,185	1,034	3,174	913
Peru	25	1	24	1	66	11
South Africa, Republic of	409	50	145	29	--	--
South West Africa	--	--	--	--	970	252
Sweden	6,144	1,037	6,889	1,284	7,172	2,973
Switzerland	--	--	--	--	30	11
United Kingdom	--	--	19	11	--	--
Total	13,496	2,045	13,742	2,449	12,013	4,426

Table 2.—U.S. imports for consumption of arsenicals, by class
(Thousand pounds and thousand dollars)

Class	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
White arsenic (As_2O_3)	26,992	2,045	27,484	2,449	24,027	4,426
Metallic arsenic	1,286	2,630	1,414	3,651	966	2,716
Sulfide	5	414	([1])	([1])	([1])	([1])
Sodium arsenate	526	74	266	52	1	5
Arsenic compounds, n.e.c	([1])	21	85	55	152	90

[1] Less than ½ unit.

Tariff.—Arsenic oxide (white arsenic) enters the United States duty free. A 1.2-cent-per-pound duty was applicable to arsenic metal.

World Review.—*Philippines.*—The first phase in the construction of a copper smelter and refinery by Lepanto Consolidated Mining Co. will be a roasting plant. Lepanto reportedly has not been able to dispose of all the concentrates it produces because of the high arsenic and antimony contents. The new plant, expected to be operational in 1978, will enable the company to recover 8,800 tons of arsenic annually.[2]

Sweden.—Production of white arsenic and arsenic metal by Boliden Aktiebolag were lower than in 1974 as work continued on developing processes for improving the environment.

[2] World Mining. V. 28, No. 10, September 1975, p. 78.

Table 3.—White arsenic (arsenic trioxide) [1]: World production by country
(Short tons)

Country [2]	1973	1974	1975 p
Brazil	76	85	e 90
France e	9,000	9,000	9,000
Germany, West	e 520	401	e 440
Japan	322	213	e 220
Korea, Republic of	e 10	13	e 10
Mexico	5,606	10,477	6,747
Peru	1,528	2,175	1,461
Portugal	r 399	290	276
South West Africa, Territory of [3]	8,981	7,319	7,345
Sweden	16,755	18,004	e 17,600
U.S.S.R. e	7,990	8,050	8,100
United States	W	W	W
Total	r 51,187	56,027	51,289

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] Including calculated arsenic trioxide equivalent of output of elemental arsenic and arsenic compounds other than white arsenic, where inclusion of such materials would not duplicate reported white arsenic production.

[2] In addition to the countries listed, Austria, Belgium, the People's Republic of China, Czechoslovakia, East Germany, Finland, Hungary, Southern Rhodesia, the United Kingdom, and Yugoslavia have produced arsenic and/or arsenic compounds in previous years but information is inadequate to ascertain whether such production has continued or not, and if so, at what levels.

[3] Output of Tsumeb Corp. Ltd. only.

Technology.—A treatment process to remove heavy metals from waste waters has been used commercially in Japan since 1974. The selective adsorbents sold by Nippon Soda Co. (Tokyo) exhibit an excellent affinity for arsenic and other heavy metals.[3]

CESIUM AND RUBIDIUM [4]

Domestic Production.—There was no domestic production of cesium- or rubidium-bearing minerals during 1975. *ALKARB*, a residue from the processing of lithium ores in previous years, and imported lepidolite were the source of domestically produced rubidium and its compounds.

Total production of cesium chemical compounds increased about 30% in 1975, while production of rubidium chemical compounds declined about 15% compared with 1974 levels.

The following companies produced cesium and rubidium chemicals during the year: Great Western Inorganics, Inc., Golden, Colo.; Kawecki Berylco Industries, Inc., Revere, Pa.; and Kerr-McGee Chemical Corp., Trona, Calif. No production of cesium and rubidium metal was reported, but small quantities of both metals were shipped from stocks.

Consumption and Uses.—Data pertaining to consumption and end use distribution of cesium and rubidium metals and compounds were not available. These materials found commercial application in the manufacture of pharmaceuticals, ultracentrifuge separation of organic compounds, and electronic apparatus such as scintillation counters, photomultiplier tubes, and photoelectric cells. Cesium, rubidium, and their compounds can be substituted for each other in some end uses.

While there were no large-scale commercial uses for cesium, cesium metal and compounds have been used in experimental magnetohydrodynamic (MHD) power generators. If MHD electrical generation is successfully developed, demand for cesium may increase in the future.

Prices.—The American Metal Market quotation on cesium metal, 99+% purity, remained unchanged at $100 to $375 per pound. The quotation on rubidium metal, 99.5% purity, also remained unchanged at $300 per pound until the American Metal Market ceased publishing the price early in 1975. At yearend the Metal Bulletin quoted the nominal price for pollucite concentrates containing a minimum 24% Cs_2O, f.o.b. source, at $12.40 to $13 per metric ton unit (22.046 pounds of Cs_2O).

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[3] Ricci, L. J. Heavy-Metals Recovery Promises to Pare Water-Cleanup Bills. Chem. Eng., v. 82, No. 27, Dec. 22, 1975, pp. 29–31.

[4] Prepared by K. L. Harris, physical scientist.

Table 4.—Prices of selected cesium and rubidium compounds in 1975

Item	Base price per pound [1]	
	Technical grade	High-purity grade
Cesium bromide	$28	$65
Cesium carbonate	29	67
Cesium chloride	30	68
Cesium fluoride	35	75
Cesium hydroxide	35	75
Rubidium carbonate	45	75
Rubidium chloride	46	76
Rubidium fluoride	51	83
Rubidium hydroxide	51	83

[1] Excludes packaging cost, 50- to 100-pound quantities, f.o.b. Revere, Pa.

Source: Kawecki Berylco Industries, Inc.

Foreign Trade.—Pollucite import data were not available. However, reported receipts by consumers indicated that pollucite was imported. Most of the pollucite consumed in the United States came from Canada.

Imports of cesium compounds decreased from 4,622 pounds valued at $167,965 in 1974 to 3,156 pounds valued at $136,203 in 1975. No cesium or rubidium metal were imported during the year.

Table 5.—U.S. imports for consumption of cesium compounds in 1975, by country

Country	Cesium chloride		Cesium compounds, n.s.p.f.	
	Pounds	Value	Pounds	Value
Canada	--	--	[1]113	$5,169
France	44	$1,307	--	--
Germany, West	1,039	52,041	1,894	75,631
United Kingdom	55	1,684	11	371
Total	1,138	55,032	2,018	81,171

[1] Estimated by Federal Bureau of Mines.

World Review.—During 1975, the Tantalum Mining Corp. of Canada, Ltd. shipped 747,279 pounds of pollucite containing 23.2% Cs_2O from its Bernic Lake, Manitoba, Canada, property; 554,096 pounds were exported to the U.S.S.R., 191,010 pounds to the United States, and 2,173 pounds to Japan.

Technology.—The U.S. Energy Research and Development Administration (ERDA) continued to sponsor joint U.S.–U.S.S.R. MHD research. A Soviet 1-megawatt MHD generator using U.S.-built power electrodes operated continuously for 127 hours. The United States and the U.S.S.R. were building a 25-megawatt MHD generator near Moscow.

In the United States, ERDA awarded a $3.5 million contract to Avco Everett Research Laboratory for coal-fired MHD power generation research. A $50 million MHD research facility will be constructed at Butte, Mont.

The geochemical dispersion of rubidium and strontium together with alteration studies could be used in defining areas suitable for detailed copper exploration.[5]

[5] Olade, M. A., and W. K. Fletcher. Primary Dispersion of Rubidium and Strontium Around Porphyry Copper Deposits, Highland Valley, British Columbia. Econ. Geol., v. 70, No. 1, January–February 1975, pp. 15–21.

GERMANIUM [6]

Consumption of germanium has not changed significantly since 1970. In 1975, the use of germanium in transistors continued to decline, but increasing use in light-emitting diodes and in infrared optical applications compensated for this loss.

Domestic Production.—The primary portion of U.S. germanium output was derived from smelter residues stockpiled in past years from the treatment of zinc concentrates from the Kansas-Missouri-Oklahoma zinc district and the southern Illinois fluorspar-zinc-lead district. This primary production was supplemented by the recovery of secondary material from waste and new scrap generated from the manufacture of electronic components and the cutting of semifabricated shapes.

Eagle-Picher Industries, Inc., of Quapaw, Okla., was the sole primary producer in 1975. Other producers of germanium using imported metal, oxide, scrap, and domestic secondary materials were Kawecki Berylco Industries, Inc., Revere, Pa.; Atomergic Chemetals Co., Carle Place, N. Y.; and Texas Materials Laboratory, Garland, Tex.

Domestic germanium production in 1975 was estimated to be 30,000 pounds, supplying about two-thirds of U.S. demand. The value of domestic production would be about $4 million based on the producer price.

Consumption and Uses.—The decline in use of germanium in transistors in 1975 was accentuated by the general slackening of business activity. The increased use of germanium in light-emitting diodes for minicomputers and digital watches, and the continued development of optical systems for infrared detection instruments more than compensated for the decreased use in transistors. The estimated distribution of consumption by classes was: Instruments 50%, electronics 46%, and others 4%. Included in the broad category of instruments are forward-looking infrared devices (FLIR), nuclear radiation measuring devices, wide-angle camera and microscope glass lenses, X-ray equipment, fluorescent lamps, and strain gages. Other uses included alloys for brazing and soldering materials, experimental catalysts for petroleum refining, and biological uses based on organogermanium compounds. Projects under research or development require small amounts of germanium, and include experiments producing columbium-germanium films that are superconductive up to 23° K, and the use of soluble germanium compounds to reduce the internal resistance of lead-acid storage batteries.

[6] Prepared by John M. Hague, mining engineer.

Table 6.—Market estimates of semiconductor shipments
(Million dollars)

	1974 [r]	1975 [r]	1976	1979
Transistors, bipolar:				
Germanium	25	16	12	9
Silicon	429	309	365	442
Signal diodes:				
Germanium	3	2	2	1
Silicon	43	32	31	28
Light-emitting diodes: (Ga, As, P, in part on Ge substrate)	28	23	26	37
Other categories	1,817	1,420	1,784	3,016
Total semiconductors	2,345	1,802	2,220	3,533

[r] Revised.

Source: Electronics. U.S. Markets Forecast 1976. V. 49, No. 1, Jan. 8, 1976, pp. 92–93.

Prices.—The U.S. producer prices for zone refined germanium and domestic germanium dioxide have been $293 per kilogram and $167.50 per kilogram, respectively, since June 8, 1970. Prices for imported germanium, quoted as a New York dealer price in Metals Week, were increased March 3, 1975, to $330 per kilogram for metal and $174.50 for germanium dioxide. The previous prices were $275 and $145.50 per kilogram, respectively.

Foreign Trade.—U.S. imports of germanium metal (unwrought, and waste and scrap) increased 20% in quantity in 1975, to 16,900 pounds valued at $1,561,000. Imports came from the U.S.S.R. 50%, West Germany 37%, Japan 4%, the Netherlands 4%, with Belgium, the United Kingdom, and Italy providing the balance.

Table 7.—U.S. imports for consumption of germanium in 1975, by country

Country	Quantity (pounds)	Value
Unwrought, and waste and scrap:		
Belgium-Luxembourg	492	$470,428
Germany, West	6,299	406,075
Italy	25	2,144
Japan	755	2,526
Netherlands	667	58,299
U.S.S.R	8,504	608,214
United Kingdom	155	13,247
Total	16,897	1,560,933
Wrought:		
Belgium-Luxembourg	2	943
Czechoslovakia	22	1,617
Total	24	2,560

World Review.—A principal source of germanium in recent years has been the Kipushi mine in Zaire. Mine production was 136,000 pounds in 1974, and was forecast as 140,000 pounds in 1975. The production of Zaire is refined in Belgium.

The Tsumeb mine in South-West Africa for many years has been a source of germanium; its production was recovered from a blister copper product refined in West Germany.

Japan produced both germanium oxide and metal in 1975, for a total output of approximately 34,000 pounds. The sources of Japan's germanium production are thought to be zinc concentrates, secondary materials, and flue dusts from germanium-bearing coals.

World production of germanium in 1975 was estimated to be in the range of 250,000 to 300,000 pounds (110,000 to 135,000 kilograms).

Technology.—A new method of fabricating light-emitting diodes was developed using a germanium substrate with a gallium arsenide phosphide epitaxial layer.[7]

Interest continued to grow in infrared photography and optics for defensive and night-fighting systems known as FLIR.

The antimicrobial properties of organogermanium compounds have promoted investigations into their pharmacological uses.[8]

The reaction of germanium with germanium dioxide to form and sublimate germanium monoxide was studied as a means of eliminating the oxygen present in germanium.[9]

[7] Electronic News. The Antenna. V. 21, No. 1071, Mar. 15, 1976, p. 12.
[8] Roskill Information Services Ltd. (London). Germanium. March 1974, p. 69.
[9] Pauleau, Y., and J. Remy. Kinetics of the Formation and Sublimination of Germanium Monoxide. J. Less-Common Metals, v. 42, No. 2, September 1975, pp. 199–208.

INDIUM[10]

Domestic Production.—Indium was produced during 1975 by ASARCO, Inc. at its Denver, Colo. plant and by Indium Corp. of America in Utica, N.Y. Indium products were made from domestic and imported zinc concentrates, and from residues or bullion forwarded from other smelters. Other U.S. companies processed or refined imported materials to produce alloys, compounds, or high-purity metal components. Domestic production was estimated to exceed imports in 1975, with other substantial contributions to supply coming from industry stocks and from secondary or scrap materials. In April, ASARCO announced that indium production was being phased down at its Denver plant because of lack of suitable indium-bearing zinc ores. Some intermittent production was to be continued for as long as 2 years. Customers were to be serviced through inventories.

Consumption and Uses.—The demand for indium was much lower in 1975 than in preceding years, but the rate of consumption increased toward yearend. While the use in electronic components continued to decline, the use in alloys, solder, and coatings continued to grow slightly, but overall consumption was estimated to be about 30% below that in 1974. The pattern of indium usage in 1975 was divided roughly as 9% in electronic components, 44% in solders, low-melting alloys and coatings, 27% in instrument applications and holding devices, and 20% in research and other uses including nuclear reactor controls.

Stocks.—Producer stocks were estimated to have declined during 1975, and combined stocks of metal compounds and material in process at yearend were thought to be of the order of 1 year's supply.

Prices.—Indium prices are based on the standard-grade metal, 99.97% pure. Higher purity grades, 99.999% indium or better, are available at a premium. The quotation published in Metals Week is for ingots, usually of 100 troy ounces, in lots of 10,000 ounces or more. This quotation was $5.50 per ounce from January to April 1975, at a range of $5.50 to $6.15 per ounce until September, and $6 per ounce for the balance of the year. The average U.S. price in 1975 was $5.80 per ounce. The quotation in Metal Bulletin (London) was $5.50 per ounce in January and $6 for the remaining 11 months of 1975.

Foreign Trade.—Imports of indium declined sharply from the record high of 811,500 ounces in 1973, and 493,000 ounces in 1974, to 113,800 ounces in 1975. The value of imports in the 3 years was $986,000 in 1973, $1,906,000 in 1974, and $629,000 in 1975. West Germany, Japan, Peru, the United Kingdom, and Canada were the principal sources of supply, with Canada showing the greatest change from major supplier in 1973 to a minor source in 1975.

The duty on unwrought, waste, and scrap indium has been 5% ad valorem since January 1, 1972 for the most favored nations. Duties on waste and scrap have been suspended until June 30, 1978. The duty on wrought indium has been 9%. Statutory duties for the U.S.S.R. and East Germany were 25% ad valorem on unwrought indium and 45% ad valorem on wrought metal.

[10] Prepared by John M. Hague, mining engineer.

Table 8.—U.S. imports for consumption of indium, by country

(Thousand troy ounces and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Unwrought, and waste and scrap:						
Belgium-Luxembourg	105	54	--	--	2	9
Canada	333	377	179	542	12	64
Germany:						
East	--	--	4	9	--	--
West	8	5	41	97	37	201
Japan	6	7	87	600	22	130
Netherlands	60	75	19	58	--	--
Peru	87	145	102	328	21	116
Switzerland	(1)	1	(1)	5	(1)	3
U.S.S.R	115	111	--	--	1	2
United Kingdom	96	199	60	259	19	102
Total	805	974	492	1,898	114	627
Wrought:						
Canada	--	--	1	8	--	--
Japan	--	--	--	--	(1)	(1)
Netherlands	6	9	--	--	--	--
Switzerland	(1)	2	--	--	--	--
United Kingdom	(1)	1	--	--	(1)	2
Total	6	12	1	8	(1)	2

[1] Less than ½ unit.

Technology.—Research was continued on the development of solar cells using indium compounds, the use of indium in photodetector and infrared detector devices, and the employment of indium as a sealant between glass and metal surfaces.

Light-emitting diodes of indium, gallium, and arsenic were employed in methane detecting devices under development by the Bureau of Mines.[11]

RADIUM[12]

The major use for radium was in therapeutic treatment of cancer. Replacement of radium by other radioisotopes continued.

Domestic Production.—There was no reported radium production in the United States during 1975. Imports, withdrawals from company stocks, and reprocessing, supplied sufficient radium to meet the small domestic demand. Radium Chemical Co., Inc., N.Y., was the main domestic dealer.

Consumption and Uses.—Radium was mostly used in the therapeutic treatment of cancer. A few tens of millicuries of radium were consumed in the production of home alarm smoke detectors. Other uses of radium were as a source of gamma radiation, used in soil moisture density gages, and in static eliminators, although polonium-210 was replacing radium. One traditional use of radium, as an illuminator on alarm clocks, was replaced by tritium.

About 900 grams of radium was used in the United States, and around 93 grams was stored in a Government-depository in Alabama during 1975. About 77 requests for deposits containing a total of 5,800 milligrams of radium were received by the Bureau of Radiological Health, U.S. Department of Health, Education, and Welfare.

Prices.—Radium prices, per milligram unencapsulated, were quoted by Radium Chemical Co., Inc. as follows: Less than 100 milligrams, \$26.50; 100 to 199 milligrams, \$25; 200 to 499 milligrams, \$22; over 5 grams, \$20. There was no increase from the 1974 prices.

Foreign Trade.—Official trade statistics did not report trade in radium, as such, but included radium with other radioactive commodities. Belgium remained the principal source of imported radium.

[11] Gerritsen, H., S. Reuman, C. Taylor, E. Crisman, and J. Beall. Use of Room Temperature Diodes in Monitoring Specific Gases in Air, Particularly Methane and Carbon Monoxide. BuMines Open File Rept. 78–75, 1974, 69 pp.; available for consultation at the Bureau of Mines libraries in Pittsburgh. Pa., Denver, Colo., Spokane, Wash., and Twin Cities, Minn.; at the Energy Research and Development Administration library in Morgantown, W. Va.; and at the Central Library, U.S. Department of the Interior, Washington, D.C.

[12] Prepared by Rebecca P. Smith, physical scientist.

World Review.—Information on radium in world markets was not readily available. The largest radium producer and supplier was the Belgian company, Union Minière S.A. Small quantities of radium were also apparently produced in Canada, in the United Kingdom, and in some centrally controlled economy countries. The industrial nations consumed most of the radium in use patterns similar to those of the United States.

Technology.—During uranium extraction nearly all the radium remains in the mill tailings, causing storage and possible environmental problems. Laboratory tests found several methods for more effective removal of the radium—separation of the slimes, which contain most of the radium, from the sand fraction, and leaching with solutions of either hydrochloric acid or ethylenediamine tetraacetic.[13]

The U.S. Environmental Protection Agency was studying potential health hazards of radioactive uranium tailings. In at least one locality, radioactive material (primarily radium) had already experienced extensive migration from the original tailings piles.

A technique for uranium prospecting was described. Radium in soil was measured by analyzing for the emitted daughter radon. Comparisons of soil radium over specific uranium occurrences were given. Advantages of this method are that results can be obtained on site, equipment is simple, and results are reproducible.[14]

SCANDIUM[15]

Minor quantities of scandium were consumed during 1975, mostly in research applications. There was no mine production of scandium, and imports and industrial stocks were sufficient to meet domestic demand. One domestic producer provided the majority of the scandium metal and compounds consumed.

Domestic Production.—In 1975 there continued to be no domestic mine production of scandium. There were two major producers of scandium metals and compounds, Research Chemicals, a division of Nucor Corp., Phoenix, Ariz., supplying about 90% of the domestic demand, and Atomergic Chemetals Corp., Plainview, N.Y. During 1975 there was a slight increase in the demand for scandium products, although this demand still totaled only a few tens of pounds.

Consumption and Uses.—Research and development continued to be the major consumer of scandium. In addition, there were three main industrial uses. High-purity scandium metal was a component in special high-intensity mercury vapor lamps used for providing outdoor lighting for events televised in color. These lamps emit an illumination approaching the quality of sunlight. Small quantities of scandium were used to strengthen magnesium alloys and scandium-46 was used for tracing underground fluid flows in petroleum production. Some scandium was consumed by the chemical and electronic industries.

Prices.—During 1975 the price of scandium metal and compounds remained stable at the 1974 levels quoted by Research Chemicals that are shown below. Scandium was also available in sheet foil of 0.001 to 0.1 inch thick at $22 to $105 per square inch in 1- to 10-square-inch lots.

Metal	Per gram, from 1 to 99 grams	Per gram, from 100 to 453 grams
Ingots	$10.50	$8.00
Powder	11.50	10.35
Chips	11.50	10.35
Distilled	19.00	15.00
Oxide:		
99.99%	5.00	4.00
99.9%	3.50	2.80
Salts [1]	2.50	2.00

[1] Salts include acetates, carbonates, chlorides, nitrates, and oxalates in most stable, hydrous form produced from oxides of 99.9% minimum purity.

Foreign Trade.—There were no official U.S. trade statistics for scandium. Scandium was included in the other minerals and metals category, however, scandium trade is believed to be minor. Based on available information, Australia and centrally controlled economy countries were the principal suppliers of scandium-bearing raw materials.

[13] Borrowman, S R., and P. T. Brooks. Radium Removal From Uranium Ores and Mill Tailings. BuMines RI 8099, 1975, 12 p.

[14] Sutton, W. R., and N. M. Soonawala. Soil Radium Method for Uranium Prospecting. Can. Min. Met. Bull., v. 68, No. 757, May 1975, pp. 51–56.

[15] Prepared by Rebecca P. Smith, physical scientist.

World Review.—Information on scandium-related activities in foreign countries was not readily available. The industrialized nations were involved in scandium research and used small quantities of scandium in industrial applications.

Technology.—A book discussing the technology, applications, occurrence, and chemistry of scandium was published.[16]

An improved terbium activated lutetium-yttrium silicate phosphor contained small quantities of scandium which increased the luminosity of the phosphor about 10% when excited with an electron beam.[17]

Films of yttrium and scandium on stainless steel substrates were tested as an improved radioactive source of electrons over thin films of titanium tritide. The limit of thermal stability was higher, with good adhesion and resistance abrasion properties.[18]

In another research project, a scandium filter that views a manganese scatterer was developed to produce a pure 2-kev beam in the National Bureau of Standards reactor. Details of the filter construction and the use of titanium with scandium to reduce the background were discussed.[19]

SELENIUM [20]

Domestic production of selenium from primary materials was 357,700 pounds in 1975, a 44% decrease from the 1974 production of 644,000 pounds.

Shipments by domestic producers decreased 58% to 284,400 pounds in contrast to the record high level of imports of 889,300 pounds of selenium. Producer stocks increased 93% over yearend 1974 stocks to 152,400 pounds at the end of 1975. The sharp drop in production and shipments and the continued increase in imports were attributed to four main factors: A recession-generated 32% drop in apparent consumption, the operating of the U.S. copper industry at approximately 30% below capacity, the closing down of one major selenium refinery and the initial phasing out of a second refinery, and competition from low selenium dealer prices. Led by Japan, world production increased 7% to 2.5 million pounds.

Legislation and Government Programs.—On December 24, 1975, the Environmental Protection Agency (EPA) enacted the National Interim Primary Drinking Water Regulations which set the maximum contaminant level for inorganic selenium in community water systems at 0.01 milligram per liter.[21]

During 1975, the General Services Administration (GSA) shipped 6,100 pounds of selenium. The GSA held 2,500 pounds of selenium at yearend.

[16] Horovitz, C. T. (ed.). Scandium—Its Occurrence, Chemistry, Physics, Metallurgy, Biology and Technology. Academic Press Inc., (London) Ltd., 1st ed., 1975, 598 pp.

[17] Fukushima, F., Y. Fukuda, M. Fukai, Y. Tsujimuto, and S. Sugai. (assigned to Matsushita Electric Industrial Co., Ltd.). Terbium Activated Lutetium-Yttrium-Scandium Silicate Type Phosphor. Jap. Pat. 89,282, July 17, 1975.

[18] Singleton, J. H., and L. N. Yannopoulos. The Use of Yttrium and Scandium for Fabrication of Radioactive Electron Emitters. J. Vac. Sci. Technol., v. 12, No. 1, 1975, pp. 414-418.

[19] Schroder, I. G., R. B. Schwartz, and E. D. Mcbarry. NBS Spec. Pub. 425, v. 1, 1975, pp. 89-92.

[20] Prepared by George J. Coakley, physical scientist.

[21] U.S. Environmental Protection Agency. Water Programs: National Interim Primary Drinking Water Regulations. Federal Register, v. 40, No. 248, Dec. 24, 1975, pp. 59566-59577.

Table 9.—Salient selenium statistics

(Thousand pounds of contained selenium)

	1971	1972	1973	1974	1975
United States:					
Production, primary	657	739	796	644	358
Shipments to consumers	663	761	851	671	284
Imports for consumption	395	430	553	837	889
Exports, metal	e 150	e 220	e 264	166	118
Shipments from Government stocks	--	14	229	224	6
Apparent consumption	908	985	1,369	1,566	1,061
Stocks, yearend, producer	182	161	106	79	152
Producers price, average per pound, commercial and high-purity grades	$9-$11.50	$9-$11.50	$9.25-$12.36	$16.53-$19.19	$18-$22
World: Production	2,506	2,721	r 2,682	r 2,709	2,508

e Estimate. r Revised.

Domestic Production.—In the United States in 1975 primary selenium was recovered at four copper refineries, AMAX Copper, Inc., Carteret, N.J.; ASARCO Incorporated, Baltimore, Md.; Kennecott Copper Corp., Magna, Utah; and The Anaconda Company, Perth Amboy, N.J.

In addition, anode slimes recovered from the electrolytic tanks of copper refineries owned by other foreign and domestic mining companies were shipped to these plants for recovery of gold, silver, selenium, and tellurium.

High-purity selenium and various selenium compounds were produced by primary and other processors from commercial-grade metal.

The Anaconda Company permanently closed its 77-year-old Perth Amboy refinery in April 1975 owing to general economic conditions adversely affecting the copper industry and to a lack of refinery feed material, formerly obtained from Anaconda's expropriated mines in Chile. ASARCO began preparing for the phaseout of its Baltimore plant in conjunction with the startup of a byproduct recovery plant at the new Amarillo, Tex. copper refinery in early 1976. The Wittenzellner Refinery Co., an associate company of the A. J. Oster Co., reported the startup in April, on a limited basis, of a new refinery in Providence, R.I. employing a unique selenium recovery process.

Data on actual recovery by domestic secondary refineries were not available but was estimated at around 10,000 pounds in 1975, reflecting the shortage of electronic scrap due to impact of the substitution of silicon for selenium in the rectifier market. Additionally, up to 175,000 pounds of secondary selenium may be processed in U.S. and Canadian refineries, principally from the recycling of selenium-bearing elements in photocopying machines used in the U.S. market.

Consumption and Uses.—Apparent consumption of selenium in 1975 consisting of shipments from primary producers, net imports, and stockpile releases decreased 32% to 1.06 million pounds. However, apparent consumption during the fourth quarter, increased to over twice the average for the first three quarters, and appeared to signal a turnaround in the weak selenium market. The reduced demand for selenium-bearing materials such as glass, pigments, specialty steels, and electronic components generally mirrored the impact of the 1974–75 recession on construction and manufacturing activity in the U.S. economy during this period. Trends in 1975 suggested the following estimate of selenium purchases and consumption by end-use categories: Electronic components including xerography, 41%; glass manufacturing, 28%; chemicals, 19%; and other, 12%.

Consumption of primary metal in the copier and duplicator market dropped slightly in 1975 although total usage increased owing to the growing contribution of recycled selenium home scrap. Competition in the duplicator market reportedly will increase following the July 29, 1975, U.S. Federal Trade Commission issuance of a consent order settling its antitrust complaint against Xerox Corp. It requires Xerox to license its copier duplicator patents and also to make certain know-how available to competitors manufacturing in the United States. In other electronic applications selenium is used in semiconductors, photoelectric cells, and in calculators.

The largest single consumer of selenium continued to be the glass manufacturing industry. Selenium is added in amounts of 0.02 to 0.3 pound per ton of glass to neutralize the green iron discoloration. Dark-colored selenium-bearing environmental glass used in office windows to reduce glare and heat transfer, established itself as a growing energy conservation application.

In its major use in the industrial chemical field cadmium sulfoselenate compounds are used widely as heat-resistant red pigments in plastics, paints, inks, and enamels. Consumption of selenium in pharmaceutical preparations held steady at about 50,000 pounds in 1975.

Demand for selenium in other end uses included the addition of small amounts of ferroselenium to improve the casting, forging, and machining characteristics of stainless steel. There are also minor applications for elemental selenium and selenium diethyldithiocarbamate in the processing of natural and synthetic rubber. In 1975 an estimated 13,000 pounds of selenium contained in sodium selenite was added to premixed chicken, swine, and turkey grain feeds as a nutrient to control diseases and to increase production.

Stocks.—The drop in consumer demand for selenium led to a declining dealer price and a sharp increase in U.S. producer stocks. Stocks increased to 152,400 pounds at a level 93% higher than the yearend 1974 stocks. However, excluding the abnormally low inventories of 1974, the producer stock levels for 1975 were still below the average quarterly stocks of 174,000 pounds held between 1970–73. The Japanese selenium industry, the world's largest producer of selenium, held at least 300,000 pounds of refined material in producer inventories at the end of 1975, despite a 15% increase in export shipments.

Prices.—Selenium is usually sold as commercial-grade powder containing 97% to 99.94% selenium, or as high-purity grade in pellets, sticks, and powder containing 99.95% to 99.99+% selenium are also available.

Domestic producer prices for commercial-grade and high-purity grades remained unchanged during the year at $18 and $21 to $22 per pound, respectively. In contrast, dealer prices for commercial-grade selenium more accurately reflected the weak demand pressures. Starting the year at $15.50 per pound, the dealer selenium price dropped steadily reaching a low quotation of $8.25 per pound in late August. By yearend, dealer prices were quoted in the $9 to $10 range.

Foreign Trade.—Selenium exports decreased 29% from 1974 to 117,596 pounds valued at $2,130,991, with an average value of $18.12 per pound. As shown in table 10, shipments to Canada (32%), the United Kingdom (25%), Poland (9%), and Sweden (9%) accounted for the major share of exports.

Selenium imports for consumption increased 6% to a record high level of 889,320 pounds while the value of imports decreased 3% from 1974 to $10,264,543. The average value of unwrought selenium metal imported during the year was $11.54 per pound and for selenium dioxide $13.54 per pound. Canada supplied 59% by quantity and 68% by value, Mexico, 11% and 3%, and Japan, 9% and 9% of all selenium imported.

U.S. import tariff schedule items 632.40, selenium metal, unwrought, other than alloys, and waste and scrap; 420.50, selenium dioxide; and 420.52, selenium salts were duty free at yearend. The duty on TSUS Item No. 420.54, other selenium compounds, was 5% ad valorem.

Table 10.—U.S. exports of selenium in 1975, by country

Country	Quantity (pounds)	Value
Brazil	2,324	$25,242
Canada	37,699	640,269
Dominican Republic	66	1,316
France	2,360	38,127
Germany, West	8,902	149,619
India	35	778
Israel	120	1,004
Japan	656	18,765
Mexico	3,747	38,394
Netherlands	7,600	68,780
Peru	1,872	8,785
Poland	11,055	97,517
Sweden	10,800	194,400
United Kingdom	29,854	841,793
Venezuela	506	6,202
Total	117,596	2,130,991

Table 11.—U.S. imports for consumption of selenium in 1975, by country

(Pounds of contained selenium)

Country	Quantity	Value
Unwrought, waste and scrap:		
Belgium-Luxembourg	27,846	$505,753
Bulgaria	18,740	219,400
Canada	506,610	6,811,389
Chile	8,830	86,762
Germany, West	2,017	30,001
Japan	72,761	782,325
Mexico	95,681	305,214
Netherlands	7,014	99,569
Norway	14,479	93,764
Peru	11,200	108,662
Portugal	4,408	40,446
Sweden	12	420
U.S.S.R	2,205	13,166
United Kingdom	15,920	161,952
Yugoslavia	61,718	541,319
Total	849,441	9,800,142
Selenium dioxide:		
Canada	3,828	44,403
Germany, West	13,767	179,859
Japan	6,522	102,262
Total	24,117	326,524
Salts:		
Germany, West	265	365
Sweden	243	7,470
Total	508	7,835
Other selenium compounds:		
Canada	13,052	91,757
Finland	992	18,406
United Kingdom	1,210	19,879
Total	15,254	130,042
Total all forms	889,320	10,264,543

World Review.—Japan ranked as the world's leading selenium producer in 1975 with an output of 919,318 pounds followed by Canada with 670,000 pounds.

Table 12.—Selenium: World refinery production by country [1]

(Thousand pounds)

Country [2]	1973	1974	1975 [p]
Australia [3]	56	64	80
Belgium-Luxembourg	[4] 65	[4] 123	[e] 105
Canada	[5] 581	[5] 736	[6] 670
Chile	[e] 40	[e] 40	26
Finland	20	21	19
Japan	[r] 789	735	919
Mexico	86	110	128
Peru	17	17	15
Sweden	137	[e] 120	[e] 100
United States	796	644	358
Yugoslavia	95	99	88
Total	[r] 2,682	2,709	2,508

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Insofar as possible data relate to refinery output only; thus countries that produce selenium contained in copper ores, copper concentrates, blister copper and/or refinery residues, but do not recover refined selenium are excluded to avoid double counting.

[2] In addition to the countries listed, the U.S.S.R., West Germany, and Zambia are known to produce refined selenium, but production is not reported and available information is inadequate for estimation of reliable output levels.

[3] Data represent production for Peko-Wallsend Ltd. only for years ending June 30 of that stated.

[4] Net exports (exports minus imports).

[5] Refinery output from all sources including imports and secondary sources.

[6] Recoverable selenium content of blister copper treated at domestic refineries, plus refined selenium from domestic primary material.

Australia.—The Tennant Creek gold, bismuth, and copper mines in Central Australia, operated by Peko-Wallsend Ltd., have been Australia's largest producer of gold, bismuth, and selenium since mid-1973. In the year ended in July 1975, two of the five operating mines, the Juno and the Warrego, produced 80,000 pounds of selenium, an increase of 43% over the previous year. The Juno mine which produced 51% of 1974–75 selenium, is nearly exhausted with less than 1 year of gold-bismuth reserves remaining containing an estimated 16,500 pounds of selenium. This unusual selenium mineralization occurs as a complex series of seleniferous bismuth sulfosalts associated with gold and copper in hydrothermally replaced magnetite-hematite within volcanic sediments.[22]

The Warrego mine has remaining reserves of 6 million tons of 2.1% copper, 0.212 troy ounce gold and 0.30% bismuth containing an estimated 1.8 million pounds of selenium. High costs and low metal prices, however, forced the cessation of copper mining and smelting in December 1974, and of the entire Tennant Creek operation in late 1975. The uncertainty of mining resuming in this area may seriously affect the future production level of selenium in Australia.

Belgium.—As part of a 5-year expansion program begun in 1974, Métallurgie Hoboken-Overpelt S.A./N.V., one of Europe's largest selenium producers, has announced plans to increase its selenium production capacity.

Canada.—Selenium production from primary raw materials has decreased since 1971 as an increasing amount of copper production from Canadian mines is derived from selenium-poor ores. The major selenium producers, Canadian Copper Refiners Ltd. (CCR) owned by Noranda Mines Ltd., and The International Nickel Co. of Canada, Ltd. have annual capacities of 500,000 pounds and 180,000 pounds of selenium, respectively. In 1975 shipments by producers amounted to 670,000 pounds valued at Can$10,515,000. In 1974 Canada consumed only 30,500 pounds of selenium domestically, 73% in glass manufacturing, and the remainder in steel and pharmaceutical uses. Hudson Bay Mining & Smelting Co. Ltd. reported recovery of 133,577 pounds of selenium from 31,643 tons of copper from the Flin Flon and Snow Lake mines refined at CCR. Hudson Bay estimated remaining reserves of selenium at 2 million pounds contained in 483,500 tons of copper.

Japan.—The output of selenium by the six Japanese producers increased 15% in 1975 to 919,318 pounds according to the Japan Mining Industry Association.[23] Mitsubishi Metal Corp. produced 42% of the total; Nippon Mining Co., Ltd. (25%); Mitsui Mining & Smelting Co., Ltd. (14%); and Sumitomo Metal Mining Co., Ltd. (12%). Domestic shipments decreased by 66% to 147,700 pounds compared with 438,700 pounds in 1974. Domestic shipments by end use were as follows in 1975: Rectifiers, 22%; glass, 27%; pigments, 18%; and miscellaneous, 33%. With internal consumption at very low levels, the producers increased exports 144% in 1975 to 590,800 pounds. In the past 2 years excess production has contributed 300,000 pounds of selenium to Japanese industry stocks.

Zambia.—Development plans called for the construction of a new precious metals refinery at Ndola to recover gold, silver, and selenium from copper tankhouse slimes and to be operational by 1976. Between 1968 and 1973 Zambia exported an average of 65,000 pounds per year of selenium contained in slimes to Europe for refining.

Technology.—The Second International Symposium on Organic Selenium and Tellurium Chemistry held in Lund, Sweden in August 1975, highlighted the success of continuing research into the essential nature of selenium in animal and human nutrition. For years thought of only as a highly toxic, possibly carcinogenic element, research now suggests that selenium may be one of the more essential and beneficial trace elements in the biological system. Selenium has been determined as the functioning part of an important enzyme, glutathione peroxidase, whose presence is indicated to help counteract certain metabolic diseases and some forms of cancer. Selenium is also known to serve as an antidote for arsenic, copper, and mercury toxicities. If future studies on man substantiate these early findings the demand for supplemental selenium in pharmaceutical and agricultural applications could increase substantially.

[22] Large, R. R. Zonation of Hydrothermal Minerals at the Juno Mine, Tennant Creek Goldfield, Central Australia. Econ. Geol., v. 70, No. 8, December 1975, pp. 1387–1413.

[23] Japan Metal Journal. Selenium Industry in 1975. V. 6, No. 14, Apr. 5, 1976, p. 11.

TELLURIUM[24]

Domestic tellurium production of 131,000 pounds in 1975 was 31% below that of 1974, and the smallest quantity since 1968. The primary producers shipped 163,000 pounds of tellurium to consumers in 1975, an increase of 2% over 1974. Producer stocks decreased 37% to 55,200 pounds. The level of imports decreased 41% to 97,400 pounds from the record high of 164,000 pounds in 1974.

Table 13.—Salient tellurium statistics
(Thousand pounds of contained tellurium)

	1971	1972	1973	1974	1975
United States:					
Production	164	257	241	191	131
Shipments to consumers	163	271	287	r 160	163
Imports for consumption	30	146	71	164	97
Apparent consumption	193	417	358	r 324	260
Stocks, yearend, producer	116	102	56	87	55
Producers price: Average per pound, commercial-grade	$6	$6	$6.05	$8.34	$9.28
World: Production	320	396	446	r 447	328

r Revised.

Domestic Production.—Tellurium was recovered as a byproduct of electrolytic copper refining by: AMAX Copper, Inc., Carteret, N.J.; ASARCO Incorporated, Baltimore, Md.; and The Anaconda Company, Perth Amboy, N.J. Commercial-grade tellurium and tellurium dioxide was produced from the precious-metal-rich anode slimes shipped from other domestic copper refinery tankhouses. High-purity tellurium, tellurium master alloys, and tellurium compounds were produced by primary and intermediate processors from commercial-grade metal and tellurium dioxide. Lower production of tellurium in 1975 was attributed to reduced copper production and to the recession-generated drop in consumption, following the industry practice of adjusting production to meet the current demand. Construction of ASARCO's new copper and tellurium byproduct refinery in Amarillo, Tex., was on schedule and startup was expected in early 1976 at which time the Baltimore facility reportedly would be phased out. Anaconda closed its 77-year-old Perth Amboy refinery in April 1975, reducing the number of primary tellurium refineries in the United States to two.

Consumption and Uses.—Apparent consumption of tellurium for the year, as indicated by producer shipments to consumers and imports for consumption, decreased 20% from 1974 to 260,000 pounds. Tellurium consumption by end use in 1975 was estimated as follows: Iron and steel production, 70%; nonferrous metal production, 19%; chemical uses, 6%; and other uses including rubber manufacturing, 5%. Tellurium is used in its elemental state as a free-machining agent in stainless steel and copper production, in the chilling of malleable cast iron, and as a curing agent and accelerator in rubber compounding. Bismuth and lead telluride alloys are used in semiconductor and minor thermoelectric applications. Tellurium is used in the dioxide state in the forming and tinting of glass and as a chemical catalyst. Applications for tellurium are somewhat limited by the relatively small availability of refined material and by price. These factors make tellurium susceptible to substitution, particularly by lead in free-machining applications; lead exhibits many of the same properties as tellurium. Selenium and sulfur can substitute for tellurium in rubber compounding and germanium or selenium also substitute in some semiconductor applications.

Stocks.—Producers stocks decreased 32,000 pounds to an historically low level of 55,000 pounds. In addition to inventories of refined tellurium, there are available stockpiles of crude materials and impure intermediate tellurium products which are accumulated for refining as needed. There is no tellurium in the U.S. Government stockpile.

Prices.—The U.S. producer price for commercial-grade tellurium was $9 per pound from January to mid-September 1975. On September 19 the U.S. producers increased the price to the Canadian

[24] Prepared by George J. Coakley, physical scientist.

producers level of $10 per pound, and maintained it at that level through the end of the year.

Tellurium is usually marketed in the form of minus 200-mesh powder or as slabs, tablets, or sticks. Normal commercial grades contain a minimum of 99% or 99.5% tellurium. Further refining through distillation and sublimation processes produces high-purity grades chiefly for use in semiconductors containing 99.95%, 99.999%, and 99.9999% tellurium.

Foreign Trade.—Tellurium metal imports decreased 42% in 1975 to 94,745 pounds valued at $926,392, with an average delivered value of $9.78 per pound. Canada with 33% and Peru with 63% supplied the major share of imports. In addition, 43,255 pounds of tellurium salts and 2,605 pounds of tellurium in compounds were also imported.

The U.S. tariff for 1975 on TSUS Item No. 632.48, tellurium metal, unwrought, other than alloys, and waste and scrap was 4% ad valorem and TSUS Items No. 421.90, tellurium compounds and 427.12, tellurium salts was 5% ad valorem. The duty on waste and scrap has been suspended until June 30, 1976. The statutory tariff on these items was 25% ad valorem. There are no data on tellurium exports.

Table 14.—U.S. imports for consumption of tellurium in 1975, by country

Country	Quantity (pounds)	Value
Unwrought, and waste and scrap:		
Belgium-Luxembourg	2,704	$22,284
Canada	31,621	316,489
Germany, West	1	634
Japan	220	1,801
Peru	59,354	579,061
United Kingdom	845	6,123
Total	94,745	926,392
Salts: Switzerland	43,255	186,139
Compounds:		
Canada	2,582	22,244
Germany, West	18	981
United Kingdom	5	294
Total	2,605	23,519
Grand total	140,605	1,136,050

World Review.—The United States continued as the world's largest producer and consumer of tellurium. In 1975, the United States produced 40% of all new refined tellurium while the U.S. apparent consumption was 79% of total world production of 328,000 pounds. The balance of world tellurium output in 1975 was distributed among Canada, Japan, and Peru.

Table 15.—Tellurium: World refinery production by country [1]
(Thousand pounds)

Country [2]	1973	1974	1975 p
Canada	[3] 93	[3] 119	[4] 80
Japan	54	57	47
Peru	58	80	e 70
United States	241	191	131
Total	446	447	328

e Estimate. p Preliminary.
[1] Insofar as possible data relate to refinery output only; thus countries that produce tellurium contained in copper ores, copper concentrates, blister copper and/or refinery residues, but do not recover refined tellurium are excluded to avoid double counting.
[2] In addition to the countries listed, Australia, Belgium, Fiji, West Germany, and the U.S.S.R. are known to produce refined tellurium, and other major copper refining nations such as Chile, Zaire, and Zambia may produce refined tellurium, but production is not reported and available information is inadequate for estimation of reliable output levels.
[3] Refinery output from all sources, including imports and secondary sources.
[4] Recoverable tellurium content of blister copper, not necessarily recovered in year designated, plus refined tellurium from domestic primary metal.

Technology.—The Emperor Gold Mining Co., Ltd., Fiji, is now producing at a rate of 7,200 pounds of tellurium per year using the first new process capable of extracting tellurium economically from gold ores. The process involved the selective flotation of the crushed ore to produce a tellurium concentrate with the gold going off in the rougher tails. The tellurium concentrates are then oxidized in a soda ash circuit followed by cyanidation, filtering, and washing to remove any remaining soluble gold. The filter cake at this stage is then leached with sodium sulfide and filtered prior to the addition of sodium sulfite to precipitate high-purity tellurium.[25]

[25] Cornwall, W. G., and R. J. Hisshion. Leaching of Telluride Concentrates: Emperor Process. Pres. at AIME Ann. Meeting, New York, Feb. 16–20, 1975, Preprint 75–B–47, 13 pp. McQuiston, F. W., Jr. R. S. Shoemaker. Gold and Silver Cyanidation Plant Practice Monograph. AIME, 1975, pp. 111–116.

THALLIUM [26]

Thallium is a rare, highly toxic metal that is produced and used in small quantities in a restricted market.

Domestic Production.—The only domestic production of thallium and its compounds was the Globe plant of ASARCO, Inc. at Denver, Colo. Thallium is recovered as a byproduct derived from residues of base metal ore refining, principally zinc. Production of compounds in 1975 was only 27% of that in 1974; no thallium metal was produced. Shipments of metal increased 71% while compound shipments decreased 8%.

Uses.—The United States consumes a small fraction of the total world production of thallium. Prior to 1972, the principal use of thallium was as a rodenticide. The current uses for thallium include low-melting alloys, low-temperature thermometers and mercury switches, additives for altering the refractive index of glass, high-density liquids for sink-float separation of minerals, photosensitive devices, infrared light transmission devices, and as an additive to mercury lamps.

Prices.—The price of thallium in 25-pound lots has been $7.50 per pound since the end of 1957.

Foreign Trade.—U.S. imports for consumption in 1975 were 927 pounds of unwrought thallium and waste and scrap valued at $4,773, and 385 pounds of compounds valued at $8,636. The amount of imported metal was 9% less than in 1974. Imports accounted for most of the material entering commerce.

Table 16.—U.S. imports for consumption of thallium in 1975, by country

Country of origin	Compounds (gross weight)		Unwrought and waste and scrap	
	Quantity (pounds)	Value	Quantity (pounds)	Value
Belgium-Luxembourg	145	$3,094	45	$2,442
Germany, West	240	5,542	--	--
U.S.S.R	--	--	882	2,331
Total	385	8,636	927	4,773

World Review.—World mine production of thallium was estimated at 30,000 pounds. In addition to the United States, Belgium, West Germany, and the U.S.S.R. produced refined thallium.

World Reserves.—Domestic and world reserves of thallium in zinc ores were estimated to be 150,000 and 640,000 pounds, respectively. Other world resources of thallium contained in known zinc districts were estimated at 750,000 pounds.

Technology.—An artificial isotope of thallium, thallium-201, was used in a procedure to determine heart damage in heart attack victims. This isotope, because it preferentially concentrates in the heart tissue, is injected into the bloodstream and later viewed from outside the body with a scintillation camera; damaged heart tissue appears as light spots in the image. Thallium-201 can also be used in preventive medicine where it indicates areas of the heart which are receiving an inadequate blood supply. The thallium tracer method eliminates the potential danger of catheter scanning devices.[27]

The only discrete thallium mineral, carlinite (Tl_2S) was discovered at the Carlin gold mine in Nevada. The black carlinite crystals are randomly scattered through black brecciated fragments of a carbonaceous, high-thallium, low-arsenic, silicified limestone. The thallium, along with carbonaceous material, was thought to be leached from the limestone during the hydrothermal event which formed the Carlin gold deposits.[28]

[26] Prepared by Ronald J. DeFilippo, physical scientist.

[27] Chemical and Engineering News. Radiochemicals Used to Scan the Heart. V. 53, No. 49, Dec. 8, 1975, pp. 21–22.

[28] Radtke, A S., and R. W. Dickinson. Carlinite, Tl_2S, A New Mineral From Nevada. Am. Miner., v. 60, Nos. 7–8, July–August 1975, pp. 559–563.

Minor Nonmetals

By Staff, Division of Nonmetallic Minerals

CONTENTS

GREENSAND [1]

Greensand, which is widely distributed in the Eastern United States, was produced in 1975 only by Inversand Co., a subsidiary of Hungerford & Terry, Inc., near Clayton, N.J. Production and sales information are not available for publication.

Raw greensand produced by the company was sold for agricultural use as a soil conditioner. Processed greensand was used by manufacturers as filter media in equipment for the removal of manganese, iron and other elements from water.

The University of Delaware received a grant of $17,051 from the Bureau of Mines early in 1976 to continue its studies of the effectiveness of greensand in removing metallic contaminants from waste waters.

IODINE [2]

The world iodine picture continued to vacillate in 1975, changing from short supply at the beginning of the year to a surplus condition at yearend. Prices maintained an even keel, ending the year at $2.59 per pound. U.S. imports during 1975 were considerably lower than in the record year of 1974, owing principally to the recession. There was a moderate reduction in stocks, which were artificially high at the beginning of the year because of a forecasted long-term shortage that was mostly discounted later. Domestic production continued to be quite small compared with imports and total consumption. The Dow Chemical Co., the only U.S. producer, maintained its small output at almost 1974 levels. However, the joint venture of Pittsburgh Plate Glass Co. (PPG) and Amoco Oil Co. to exploit the iodine brines near Woodward, Okla., is moving ahead on schedule and will be onstream in the first quarter of 1977. This will make an appreciable contribution to the U.S. supply. In addition, at least one other company has definite plans to exploit brines in adjacent areas in the near future.

Japan, the major iodine producer of the world, appears to have solved its production problems and indeed may have increased its reserves and sustained production capability at least for the near term. Production rose 3% in 1975 but was still 9% lower than the record 16.5 million pounds produced in 1972. Chilean iodine production continued at a moderate level of 4.3 million pounds in 1975; exports to the United States were of minor consequence.

Legislation and Government Programs.—

[1] Prepared by William F. Keyes, physical scientist.
[2] Prepared by J. W. Pressler, physical scientist.

On December 31, 1975, the Government strategic stockpile contained 8,011,814 pounds, the same as a year earlier. The stockpile objective for iodine had been reduced to zero in early 1973. However, congressional approval to dispose of the excess iodine had not been obtained by yearend.

The depletion allowance for iodine remained at 14% of gross income, and was not to exceed 50% of net income without the depletion deduction.

Domestic Production.—Dow Chemical recovered crude iodine from well brines at its Midland, Mich., plant, as a coproduct with bromine, calcium and magnesium compounds, and potash by its standard two-step process.

Consumption and Uses.—Based upon a Bureau of Mines canvass, approximately 4.4 million pounds of crude iodine was consumed by 31 plants in 14 States. Leading iodine-consuming States in 1975, in descending order of magnitude, were Missouri, New York, Pennsylvania, and New Jersey, which together accounted for more than two-thirds of the total crude iodine consumption.

About 2.2 million pounds of iodine went into organic compounds, 730,000 pounds into potassium iodide, 633,000 pounds into resublimed iodine, and 845,000 pounds into various other inorganic compounds. Possibly an additional 1 million pounds may have gone into other intermediates, mainly for catalytic use. It is expected that this catalytic use will outpace the other categories of iodine's use and be somewhat related to output of the automotive tire industry.

The annual canvass of the industry for consumption information is indicative of the pattern, but because of proprietary end uses, it is difficult to establish an accurate demand pattern by use. Again in 1975, imports alone were more than reported consumption, with a net difference of 909,000 pounds. Estimated consumption of iodine in the United States probably was close to 6.2 million pounds in 1975.

Table 1.—Crude iodine consumed in the United States

Products	1974			1975		
	Number of Plants	Consumption		Number of Plants	Consumption	
		Thousand pounds	Percent of total		Thousand pounds	Percent of total
Resublimed iodine	6	544	9	6	633	14
Potassium iodide	32	1,918	32	9	730	17
Other inorganic compounds	21	1,096	18	15	845	19
Organic compounds	23	2,517	41	21	2,193	50
Total	[1] 33	6,075	100	[1] 31	[2] 4,400	100

[1] Nonadditive total because some plants produce more than one product.
[2] Data do not add to total shown because of independent rounding.

A linear regression analysis of the Bureau-reported consumption of crude iodine in the manufacture of first downstream products indicated a 20-year (1956–75) historical-trend growth rate of slightly under 3%. In 1975, consumption of resublimed iodine increased 16% compared with 1974, and followed the latest 5-year growth rate trend of 11% per year. Total inorganics decreased 38% in 1975 compared with the previous year. Total organics decreased 13% in 1975, but the latest 5-year growth rate trend was over 5%.

In 1975, the major downstream uses were divided into the following categories: Catalysts for synthetic rubber, animal and fowl food supplements (mainly for cattle), stabilizers (as in nylon precursors), inks and colorants, pharmaceuticals, and sanitary uses. Iodine was also consumed in the making of high-purity metals, motor fuels, iodized salt, photo chemicals, smog inhibitors, lubricants, and many small uses, including cloud seeding. The use of iodine compounds as radio-opaque diagnostic agents in medicine is a minor but important application.

Prices.—Although the quoted price in 1975 was $2.59 per pound of crude iodine, prices were soft by yearend with some discounting in effect. Reflecting this, the average price for all of the iodine exported from Japan, which controls the bulk of the world iodine trade, was $2.28

per pound in 1975. However, this was a 22% increase over the average 1974 price of $1.87. U.S. demand did not live up to the expectation at the beginning of the year and moderated to influence both price and inventories. The quoted U.S. prices for iodine and iodine compounds at yearend 1975 follow:

	Per pound
Crude iodine, drums	$2.59
Resublimed iodine, U.S.P., granular, 100-pound drums, f.o.b. works	$4.00–5.25
Calcium iodate, drums, delivered	3.32
Calcium iodide, 35-pound drums, f.o.b. works	5.98
Potassium iodide, U.S.P., granular, crystals, drums, 1,000-pound lots, delivered	3.76
Sodium iodide, U.S.P., crystals, 300- to 500-pound lots, drums, freight equalized	5.16
Iodoform, N.F., drums, 300-pound lots, f.o.b. works	7.75–14.30

Source: Chemical Marketing Reporter, Dec. 29, 1975.

Foreign Trade.—Crude iodine imported into the United States in 1975 decreased 33% in quantity compared with 1974, and total value decreased 21%. The average value of imported crude iodine rose from $1.86 per pound in 1974 to $2.21 in 1975. Of the 5.3 million pounds of crude iodine imported, 93% was from Japan and 7% was from Chile. In a surplus, price-discounted situation, Chilean iodine did not find the ready market in the United States that it traditionally enjoyed prior to 1972. Imports of other iodine compounds, including resublimed iodine, were insignificant compared with imports of crude iodine.

Tariff rates were 8 cents per pound on resublimed iodine and 12 cents per pound on potassium iodide, with crude iodine entering the United States duty free.

Table 2.—U.S. imports for consumption of crude iodine, by country
(Thousand pounds and thousand dollars)

Country	1973		1974		1975	
	Quantity	Value	Quantity	Value	Quantity	Value
Chile	88	160	1,505	2,972	365	856
Japan	6,061	10,425	6,465	11,877	4,944	10,865
Total	6,149	10,585	7,970	14,849	5,309	11,721

World Review.—*Chile.*—Production of crude iodine in 1975 dropped 14% to 4.3 million pounds, compared with a reported 5.0 million pounds in 1974. Chile's production of crude iodine is associated with the production of natural potassium and sodium nitrates, which decreased 5.6% and 1.2%, respectively.

Nitrates and its associated iodine production earned Chile over $47 million ($5 million from iodine alone), and was the third most important mineral export. The State-owned corporation Sociedad Química y Minera de Chile S.A. (SOQUIMICH) produced all of the reported nitrates and iodine from the three mines and plants.

Because the price was initially pegged in 1975 at a level higher than farmers were willing to pay, Chile's domestic sales of nitrates suffered. Eventually the Chilean Government provided a special credit to farmers for nitrate purchases, unfortunately too late in the growing season to be of much help. The decline in export receipts in 1975 versus 1974 (from $54 million to $42 million), however, is due more to fall-off in volume than price. After running a $25 million deficit in 1975, SOQUIMICH is abandoning all investment projects that would lead to increased production and is retaining only those that will reduce costs. Production and sales are dropping markedly, but the industry is beginning to operate without the need for subsidies.

Chile did not regain any of its iodine export market to the United States in 1975; the U.S. Bureau of the Census reported only 365,000 pounds was imported, a 76% decrease from 1974 figures.

China, People's Republic of.—China's iodine production appeared to be balanced, importing only token amounts from Japan and Chile. Imports from Japan were 22,000 pounds in 1975, the same as 1974. No figures are available for Chile's 1975 iodine exports to China, but they were probably of minor significance.

Indonesia.—Ise Chemical Industries, Ltd's joint venture with Mitsui & Co. Ltd., and the Indonesian Government will have a capacity of 600,000 pounds of iodine per year when completed. Indonesia produced 73,000 pounds of crude iodine in 1975, a 28% increase over 1974 production.

Japan.—Japan continued to dominate the world iodine picture during 1975. Its output of 15 million pounds of crude iodine was a slight increase (2.5%) over 1974 but a decline of 9% from the record of 1972. The United States imported 4.9 million pounds of crude iodine from Japan in 1975, amounting to 33% of Japan's total iodine exports. Japan's production exceeded exports by 3.7 million pounds in 1975 and indicated a buildup of inventories due to the softer market at yearend. Japan's other important iodine export markets included the European Community countries, Switzerland, India, the U.S.S.R., and Canada, the same as in 1974.

During 1975, Ise Chemical Industries, Ltd.'s position in iodine production became more dominant, with all new plant construction in Japan being undertaken by them. In 1976 Ise was to complete a new 2.6 million-pound-per-year plant at Miyazaki, Kyushu, and a new 4 million-pound-per-year plant at Kurosaki.

It is reliably reported that the level of Japan's output of crude iodine may approach 18 million pounds per year by 1977, with the series of new plants and plant expansions now in progress. Chiba Prefecture is having new and greater development consideration, as the gas needs are now considered more important than the ground subsidence and environmental problems of recent times. The new Miyazaki area iodine reserves are very large and comparable to the reserves elsewhere in Japan.

U.S.S.R.—Soviet iodine production capacity was reported as 3.8 million pounds per year. Plants were operated at a high percentage of capacity. During 1975, Japan exported 396,000 pounds to the U.S.S.R., compared with 198,000 pounds in 1974.

MEERSCHAUM [3]

For the first time since 1972 crude meerschaum was imported for domestic consumption in 1975 and totaled 11,263 pounds in quantity and $20,337 in value. For comparison, imported meerschaum in 1972 totaled 11,139 pounds valued at $22,791. The principal source of imports in 1975 was the Somali Republic (99.8%).

QUARTZ CRYSTAL [4]

Cultured quartz crystal production increased 37% from 528,664 pounds in 1974 to 724,343 pounds in 1975. Consumption of cultured quartz increased, while consumption of natural quartz dropped for the first time since 1971. Exports of natural and cultured quartz increased significantly in 1975. Production of finished piezoelectric units increased 11% to 39,545,000 units.

Legislation and Government Programs.—The stockpile objective for electronic-grade quartz crystal remained at 209,000 pounds. As of December 31, 1975, the Defense Materials Inventory was 2,717,978 pounds, which included predominantly stockpile-grade material. Sales of stockpile excesses totaled 335,117 pounds in 1975.

Domestic Production.—The publication Arkansas Mineral Producers and Production 1975, prepared by the Arkansas Geological Commission, listed two operations as producers of quartz crystal: Ocus Stanley, Mt. Ida, Ark., and Terry Mining Corp., Midwest City, Okla. Total production for these two companies was listed as 29,840 pounds. The report gave no indication as to the quality or characteristics of the quartz crystals.

[3] Prepared by A. C. Meisinger, industry economist.

[4] Prepared by Stanley K. Haines, physical scientist.

Table 3.—Salient electronic- and optical-grade quartz crystal statistics
(Thousand pounds and thousand dollars unless otherwise noted)

	1972	1973	1974	1975
Production of cultured quartz	160	r 307	529	724
Imports of electronic- and optical-grade natural quartz crystal:				
Quantity	65	104	389	NA
Value	78	92	368	NA
Exports of electronic- and optical-grade quartz crystal:				
Quantity	149	287	299	486
Value	1,228	3,283	4,398	5,713
Natural:				
Quantity	90	205	166	313
Value	587	1,933	1,634	1,656
Cultured:				
Quantity	59	82	133	173
Value	641	1,350	2,764	4,057
Consumption of raw electronic-grade quartz crystal	189	249	285	332
Natural	87	99	122	90
Cultured	102	150	163	242
Production piezoelectric units, number thousands	25,555	27,006	35,541	39,545

r Revised. NA Not available.

Seven companies reported production of cultured quartz for use by the quartz-crystal-cutting industry. These companies were P. R. Hoffman Co., Carlisle, Pa.; Motorola, Inc., Chicago, Ill.; Bliley Electric Co., Cortland, Ohio; Sawyer Research Products, Inc., Eastlake, Ohio; Thermodynamics Corp., Shawnee Mission, Kans.; Western Electric Co., Inc., North Andover, Mass.; and Electro Dynamics Corp., Shawnee Mission, Kans.

Cultured quartz production increased 37% to 724,343 pounds in 1975. Production was stimulated by the tremendous increase in popularity of citizen's band (CB) radios and electronic watches.

Sawyer Research Products, the leading producer of cultured quartz, twice announced expansion plans. The first announcement was for a 15% increase in capacity at an investment of $2.5 million. Later, an additional $2 million expansion program was announced, thereby increasing capacity by a total of 30%.

Consumption and Uses.—Consumption of raw (uncut natural or cultured crystal) quartz crystal increased 17% to 332,187 pounds in 1975. Consumption of cultured continued to dominate over that of natural quartz. Cultured quartz consumption increased 49% over the 1974 level. Natural quartz consumed declined 26% in 1975.

The 1975 production and consumption data were derived from reports received from 34 crystal-cutting operations in 17 States. Finished piezoelectric units were produced by 43 companies, of which 23 also had cutting operations. Of the total cutting operations, 21 cut cultured quartz only and 13 cut both natural and cultured quartz. None of the reporting companies cut natural crystal only. Illinois was the leading quartz-crystal-consuming State, followed by Pennsylvania, Kansas, and Massachusetts.

Piezoelectric units were manufactured in 17 States. Thirty plants in Kansas, Illinois, Florida, Pennsylvania, and California supplied 80% of the total output of finished crystal units. Oscillator plates comprised 75% of production. The remainder was used for filter plates, telephone resonator plates, and other items.

Reeves-Hoffman Division of Dynamics Corp. of America, a leading producer of quartz crystals for watches, announced plans for completion of a new plant by the end of 1976. The plant, which will produce AT crystals as well as watch crystal units, will double the company's manufacturing space and will be located in McConnellsburg, Pa.

Stocks.—Total stocks of raw quartz crystal (cultured and natural) increased 22% from 256,373 pounds in 1974 to 311,556 pounds in 1975. Of this total, 179,498 pounds was cultured quartz and 132,058 pounds was natural quartz.

Foreign Trade.—U.S. exports of natural quartz crystal almost doubled, from 165,837 pounds in 1974 to 313,330 pounds in 1975. Exports of cultured quartz increased 30% from 133,035 pounds in 1974 to 172,689 pounds in 1975. The average price per pound was $5.29 for natural quartz and $23.49 for cultured quartz.

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Lime.—Consumption of lime in New Jersey declined 5% from 119,200 tons in 1974, to 113,313 tons in 1975. There was no production of lime in New Jersey in 1975.

Magnesium Compounds.—Production of magnesium compounds decreased 32% compared with 1974 with a 31% increase in average unit value. Refractory magnesia was produced in Cape May County from dolomite and domestic seawater.

Marl, Greensand.—Greensand, which is widely distributed in the eastern United States, was produced in 1975 only by the Inversand Co., a subsidiary of Hungerford and Terry Inc., near Clayton. Raw greensand produced was sold to Zook and Tanck, of Gap, Pa., for agricultural use as a soil conditioner. Processed greensand was used by manufacturers as filter media in equipment for the removal of manganese, iron, and other elements from water.

Perlite.—Crude perlite mined in Colorado, Nevada, and New Mexico was expanded at two plants in Middlesex County and used in roof insulation, plaster and concrete aggregate, masonry and cavity filler, and as a soil conditioner.

Sand and Gravel.—The total output of sand and gravel decreased 27% in quantity and 16% in value from that of 1974. Production of sand and gravel for construction declined 30% in quantity and 27% in value compared with 1974. Average value per ton was $2.04 in 1975. Of the 10.3 million tons of sand and gravel used for construction, 57% was processed sand, 28% was processed gravel, and 15% was unprocessed sand and gravel. Output of industrial sand decreased 16% in quantity and 5% in value with an average unit value of $5.98 per ton. Industrial sand accounted for 21% of the tonnage and 41% of the value of all sand and gravel produced in the State. The primary uses of industrial sand were for glass, molding, and foundry purposes. Most of the industrial sand was produced in Cumberland County. Dredging operations were the principal method for recovery of the sand. The number of sand and gravel operations dropped by 16 to 73. Production came from 14 of the State's 21 counties. The leading producing counties, ranked by tonnage, were Cumberland, Burlington, Ocean, Morris, and Middlesex. Cumberland County ranked first in value.

Table 5.—New Jersey: Construction and industrial sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1974		1975	
	Quantity	Value [1]	Quantity	Value [1]
Construction:				
Processed:				
Sand	8,309	15,588	5,901	11,840
Gravel	4,122	11,226	2,847	7,786
Unprocessed:				
Sand and gravel	2,246	1,843	1,535	1,345
Industrial:				
Sand	3,247	17,272	2,730	16,321
Gravel	--	--	W	W
Total [2]	17,924	45,929	13,012	37,293

W Withheld to avoid disclosing individual company confidential data; included with "Construction."

[1] Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant for blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

[2] Data may not add to totals shown because of independent rounding.

Imports of raw natural quartz crystal, valued at more than $0.50 per pound, increased from 388,677 pounds valued at $367,943 in 1974 to 584,647 pounds valued at $884,627 in 1975. This category includes both electronic-grade quartz and the lower quality material, lasca. Brazil was the source for 99% of this material. Imports of quartz valued at less than $0.50 per pound were 902,625 pounds valued at $46,111 in 1975. Brazil was the principal source of the category (91%) with Canada, the Netherlands, the United Kingdom, and West Germany providing the balance.

World Review.—*Brazil.*—Brazil continued as the principal world source for electronic-grade natural quartz and lasca for use by fused quartz and cultured quartz producers. Brazil announced an export quota for 1975 of 7.7 million pounds of lasca. The f.o.b. floor prices for lasca were $2.72 per pound of first-grade lasca, $1.59 per pound of second-grade lasca, and $0.76 per pound of third-grade lasca. The criteria for quota distribution included consideration of price and exporters and importers traditional experience in dealing with Brazilian companies.

United Kingdom.—Cultured quartz for use in various piezoelectric units was produced by two companies in the United Kingdom: Solford Electrical Instruments Ltd., a division of U.K. General Electric Co., and Standard Telephones and Cables Co. Ltd. Both companies produce cultured quartz for internal use only. Both grow the quartz using hydrothermal synthesis. Annual production of cultured quartz is estimated to be 26,880 pounds.

Exports of cultured quartz are estimated to be 3,360 pounds; most is sent to overseas subsidiaries of Standard Telephones and Cables Co. Sources of lasca (quartz feedstock) include Brazil, India, Africa, and the United States.

Japan.—Five firms produced cultured quartz in Japan: Toyo Communication Equipment Co., Ltd.; Kinsekisha Laboratories, Ltd.; Nippon Dempa Electro Instruments Co., Ltd.; Meidensha Electric Manufacturing Co., Ltd.; and Daiwa Shinku Kogyosho. Estimates of the production of the hydrothermally grown quartz range between 24,255 and 44,100 pounds tons per month. Toyo Communication is the only exporter of cultured quartz. Lasca sources are Brazil and the United States.

Technology.—Use of newly developed devices to replace crystal units in CB and other radios could lead to a decline in the number of quartz crystals required for each radio. The digital or phase-locked-loop synthesizers use only a single master crystal to generate all of the channels rather than the current 12 to 14 crystals used in most CB radios.[5]

STAUROLITE [6]

Staurolite is a complex iron-aluminum silicate of uncertain and most likely variable composition. It occurs as opaque crystals that are reddish-brown to black, have a specific gravity of 3.65 to 3.77, and fall between quartz and topaz in hardness (7 to 8 on Moh's scale). Aside from a small rock-shop trade in cruciform-twinned crystals (notably from deposits in Georgia, North Carolina, and Virginia) that have been called "fairy crosses" and are sold as curios or amulets, all the staurolite produced commercially in the United States is a byproduct obtained by high-intensity magnetic separation of a heavy-mineral mixture recovered by E. I. du Pont de Nemours & Co., Inc., from beach sand in a glacial age deposit in Clay County, Fla.

Formerly the staurolite concentrate was used only as an ingredient in portland cement mixtures, but more recently this product (which may contain minor proportions of various other minerals and averages about 45% Al_2O_3, 15% Fe_2O_3, and 30% SiO_2) is being marketed by du Pont under two trade names, as Starblast for use as a sandblast abrasive, and Biasil for mixing with bentonite and other substances to prepare special-purpose foundry sand.

Quantitative production data are not released for publication, but the 1975 output of staurolite was 37% less than that of 1974, while shipments decreased 34% in tonnage and 10% in total value.

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[5] Electronics. How To Design Fewer Crystals Into Citizen's Band Radios. V. 48, No. 22, 1975, p. 112.
[6] Prepared by J. Robert Wells, physical scientist.

STRONTIUM [7]

Domestic consumption of strontium on a carbonate basis was estimated at 15,000 short tons in 1975, a 40% decrease from 1974 consumption. Imports of strontium minerals decreased 44% to 21,613 short tons. Imports of strontium chemicals, primarily from Canada, decreased 64%.

Legislation and Government Programs.—Government stockpiles contained 14,408 tons of non-stockpile-grade celestite at yearend. This material has been declared excess; however, authorizing legislation must be obtained before it is released for disposal.[8]

Domestic Production.—Strontium minerals have not been produced commercially in the United States since 1959. However, a number of firms produced strontium compounds from imported celestite.

Table 4.—Major producers of strontium compounds, 1975

Company	Location	Compounds
Atomergic Chemetals Co	Carle Place, N.Y	Various compounds.
J. T. Baker Chemical Co	Phillipsburg, N.J	Do.
Barium & Chemicals, Inc	Steubenville, Ohio	Do.
Chemical Products Corp	Cartersville, Ga	Carbonate.
FMC Corp	Modesto, Calif	Carbonate, nitrate.
Hercules, Inc	Glens Falls, N.Y	Chromate.
King Laboratories, Inc	Syracuse, N.Y	Metal alloys.
Mallinckrodt Chemical Works	St. Louis, Mo	Various compounds.
Mineral Pigments Corp	Beltsville, Md	Chromate, molybdate.
NL Industries, Inc., Tam Div	South Amboy, N.J	Titanates.

Consumption and Uses.—Domestic consumption of celestite in the manufacture of various strontium chemicals appears to have stabilized in 1975 even though carbonate from Canada was available in large quantities. Although quantitative information concerning consumption is incomplete, sales of domestically produced strontium carbonate to manufacturers of glass for color television picture tubes declined. Celestite consumption for the manufacture of pyrotechnics appeared to have been stabilized.

Miscellaneous applications for strontium compounds included ferrites, greases, ceramics, plastics, toothpaste, pharmaceuticals, paint, electronic components, welding fluxes, and high-purity zinc. Small quantities of strontium metal were produced by research companies.

Prices.—At yearend, prices quoted in Chemical Marketing Reporter were as follows: Strontium carbonate, technical—bags, carlots, works, 18 cents per pound; strontium nitrate—bags, carlots, works, $24 per 100 pounds, up $3 from 1974. Prices for strontium minerals are usually determined by direct negotiations between buyer and seller and are seldom published. The average value of imported strontium minerals at foreign ports was $38 per short ton, up $8 from 1974.

Foreign Trade.—Imports of strontium minerals totaled 21,613 tons, a 44% decrease from 1974. The material was imported from Mexico and Spain. Imports of strontium compounds decreased 64% from those of 1974 with 98% of the material coming from Canada. Quantitative data on U.S. exports of strontium compounds were not available.

[7] Prepared by W. Timothy Adams, physical scientist.

[8] General Services Administration. Stockpile Report to the Congress. July–December 1975, page 10.

Table 5.—U.S. imports for consumption of strontium minerals,[1] by country

Country	1974		1975	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Mexico	30,935	$875	15,344	$613
Spain	7,496	270	6,269	213
Total	38,431	1,145	21,613	826

[1] Strontianite or mineral strontium carbonate, and celestite or mineral strontium sulfate.

Table 6.—U.S. imports for consumption of strontium compounds, by country

Country	1974 Pounds	1974 Value	1975 Pounds	1975 Value
Strontium carbonate, not precipitated:				
Canada	2,910,005	$274,485	--	--
Switzerland	2,205	647	--	--
Total	2,912,210	275,132	--	--
Strontium carbonate, precipitated:				
Canada	12,346,082	1,867,147	5,090,940	$864,950
China, People's Republic of	--	--	22,046	4,886
Germany, West	39,242	9,944	2,425	732
Italy	634,928	163,204	--	--
Netherlands	4	421	--	--
Switzerland	79,366	22,157	--	--
United Kingdom	39,682	7,836	--	--
Total	13,139,304	2,070,709	5,115,411	870,568
Strontium chromate:				
Belgium-Luxembourg	22,000	19,300	--	--
Canada	618,450	503,357	185,850	136,617
France	78,483	43,075	--	--
Germany, West	74,333	78,584	--	--
United Kingdom	20,000	17,262	--	--
Total	813,266	661,578	185,850	136,617
Strontium nitrate:				
Canada	109,333	20,480	725,740	166,442
Germany, West	1,100	379	--	--
Total	110,433	20,859	725,740	166,442
Strontium compounds, n.s.p.f.:				
Canada	--	--	43,700	13,114
France	2,865	6,956	5,181	13,800
Germany, West	116,109	59,660	120,181	59,230
Japan	--	--	4,409	1,533
United Kingdom	2	314	--	--
Total	118,976	66,930	173,471	87,677
Grand total	17,094,189	3,095,208	6,200,472	1,261,304

World Review.—*Canada.*—Kaiser Strontium Products, Ltd., marketed strontium chemicals worldwide from its plant at Point Edward, Cape Breton Island, Nova Scotia. Solution of technical problems appears to have resulted in overcapacity in the strontium industry.

Table 7.—Strontium minerals: World production, by country
(Short tons)

Country [1]	1973	1974	1975 [p]
Algeria [e]	2,100	2,100	--
Argentina	817	580	[e] 550
Canada [e]	65,000	60,000	28,000
Iran [e 2]	330	330	330
Italy	810	827	[e] 800
Mexico	20,143	32,568	16,228
Pakistan	3	400	475
Spain	8,818	9,370	[e] 9,400
United Kingdom	4,782	2,646	[e] 3,000
Total	102,803	108,821	58,783

[e] Estimate. [p] Preliminary.
[1] In addition to the countries listed, West Germany, Poland, and the U.S.S.R. produce strontium minerals, but output is not reported quantitatively, and available information is inadequate to permit formulation of reliable estimates of output levels.
[2] Year beginning March 21 of that stated.

Technology.—Research sponsored by the U.S. Energy Research and Development Administration under contract with Union Carbide Corp. resulted in a high-efficiency thermochemical cycle for the decomposition of water. The cycle is based on reactions of chromium and strontium compounds. Temperatures required have already been exceeded in high-temperature gas-cooled nuclear reactors; 100% yield was obtained below 800°C. There are no difficult gas separation problems. The cycle is a potential source of hydrogen for synthetic and for fuel uses.[9]

WOLLASTONITE [10]

Wollastonite is a naturally occurring calcium metasilicate, usually white or light colored and sometimes acicular to silky-fibrous in structure, with the theoretical composition of $CaO \cdot SiO_2$, equivalent to 48.3% CaO and 51.7% SiO_2. The mineral, used as a ceramic raw material, as a filler for plastics and asphalt products, as a pigment and extender for paints, and in miscellaneous minor applications, was mined in the United States in 1975 only by Interpace Corp. at an underground operation in Essex County, N.Y. Specific output data were not released for publication, but the tonnage produced in 1975 was 14% less than in 1974, while the reported total value was 2% higher. An article published in an industrial magazine that presented a review of the world situation, historical and current, with regard to wollastonite production and utilization, stated that present U.S. output of the mineral is estimated to be 66,000 to 77,000 tons per year.[11]

Production of wollastonite outside the United States in 1975 was reported in Finland, 14,430 tons (flotation concentrate); Turkey, 11,350 tons; India, 1,045 tons; and Mexico, 600 tons.

Chemical Marketing Reporter, December 29, 1975, quoted the price of wollastonite, fine paint grade, bagged, in carload lots, f.o.b. works, as $43.80 per ton; medium paint grade, $33.00 per ton. The December 29, 1975, issue of American Paint & Coatings Journal quoted prices ranging from $29.00 to $50.50 per ton for paint-grade wollastonite. The price range quoted in the December 1975 issue of Industrial Minerals (London) for wollastonite (imported, ground, bagged, c.i.f. main European port) was approximately equivalent to $107 to $132 per short ton.

ZEOLITES [12]

The Federal Bureau of Mines, the U.S. Geological Survey, the National Science Foundation, the American Chemical Society, 18 industrial organizations, the Mineralogical Society of America, the Clay Minerals Society, and the Society of Economic Geologists cooperated in conducting an international conference on natural zeolites in 1976. The 1975 edition of a primary reference book [13] included a chapter devoted to these minerals. These developments indicate the growth of interest in zeolites in the technical, industrial, and academic communities.

The Bureau of Mines has done a limited amount of research [14] on zeolites and is accumulating information on development of markets and production capacity. An adequate data base is not yet available from which to make firm economic assessments, but the potential utility of these minerals is so great that a review of the known data is being included in the Minerals Yearbook.

According to Breck,[15] zeolites are natural

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[9] Bamberger, C. E., and D. M. Richardson. Thermochemical Decomposition of Water Based on Reactions of Chromium and Strontium Compounds. Chemtech., v. 6, No. 5, May 1976, pp. 330–331.

[10] Prepared by J. Robert Wells, physical scientist.

[11] Industrial Minerals (London). Wollastonite: USA Dominates Both Production and Consumption. No. 94, July 1975, pp. 15–17, 19, 21–23, 29.

[12] Prepared by Robert A. Clifton, physical scientist.

[13] Olson, R. H., D. W. Breck, R. A. Sheppard, and F. A. Mumpton. Zeolites. Ch. in Industrial Minerals and Rocks, ed. by S. J. Lefond. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 4th Edition, 1975, pp. 1235–1274.

[14] Munson, R. A. Properties of Natural Zeolites. BuMines RI 7744, 1973, 13 pp.

Munson, R. A., and R. A. Clifton. Natural Gas Storage With Zeolites. BuMines TPR 38, 1971, 9 pp.

[15] Breck, D. W. Zeolite Molecular Sieves: Structure, Chemistry, and Use. John Wiley & Sons., Inc., New York, 1974, 771 pp.

or synthesized, crystalline, hydrated aluminosilicates of Group I and Group II elements, particularly sodium, potassium, magnesium, calcium, strontium, and barium. There are 34 zeolite mineral species and about 100 types of synthetic zeolites, but only a few currently have practical significance. Structurally, they are framework aluminosilicates, and to be used as a molecular sieve the zeolite structure must remain intact after complete dehydration.

Domestic Production.—There is no sustained production of natural zeolites in the United States. Several companies have mined and sold several thousand tons of these minerals over the last few years, but this has been mainly on an "as ordered" basis.

Several companies with proven ore bodies have done at least the basic planning to be ready to react to market demand. A few of the ore bodies have had the overburden removed, and some even have stockpiles of mined zeolites ready for shipment. At least one company has mined, processed, and pelletized natural zeolites in stock.

Zeolites that are manufactured by synthesis from various raw materials may be categorized into two groups; the pure zeolites and zeolite-containing catalysts. There is an area of overlap when the pure zeolites are used as catalyst carriers or support for other active ingredients, but these will be treated only as the pure zeolites and designated "synthetic zeolites." The "zeolitic catalysts" will have that designation and will be treated separately because they usually contain zeolites in a host matrix. The zeolite content of Mobil Oil Corp.'s Durabead 5 cat-cracking catalyst was 25% in a silica-alumina matrix, but the average zeolite content seems to be about 10%.

There is no finite production data available on synthetic zeolites, but one manufacturer estimated 1974 production at 4,000 tons and an annual growth rate of 10% to 12%. The average 1972 price was $2,000 per ton.

Production data on zeolitic catalysts of necessity will remain less than finite; much of the basic research is done by the using oil companies, and the manufacturing is done under secrecy agreements with the synthesizer. The producers say that the zeolite content of the 130,000 tons of cracking catalysts used annually is about 10%, or 13,000 tons. The 126,000 tons used in 1972 was worth $66 million.

Consumption and Uses.—*Natural Zeolites.*—There are at least five market areas where zeolites are being used commercially in the United States. The first such use was unrecognized until comparatively recent years, when it was discovered that various zeolites were major constituents of the pozzolans in pozzolanic cement. Analcime, chabazite, and clinoptilolite are the varieties identified so far in European pozzolans and occur in amounts of 20% to 80% of the constituent minerals. A clinoptilolite-rich tuff near Tehachapi, Calif., was the source of the pozzolan for Monolith Portland Cement Co. for many years.

The second, and fastest developing market at present relates to the specificity of clinoptilolite for removal of the ammonia ion (NH_3) from sewage waters. This was first demonstrated by Mercer[16] in 1970 with a mobile unit at Lake Tahoe, Calif., in which 97% of the entrained ammonia was removed from sewage waters. A 600,000-gallon-per-day (gpd) plant at Minneapolis-St. Paul, Minn., using 90 tons of clinoptilolite went onstream in early 1974. Two Virginia plants, one a 10-million-gpd unit at Reston using 1,800 tons of clinoptilolite and the other a 54-million-gpd unit at Alexandria, will be onstream shortly. Attrition and replacement rates for zeolites in this use are not known, but full replacement is not expected to be needed for 5 to 10 years.

The third commercial use at present is in the field of drying and purification of acidic natural gases. The chabazite-erionite zeolites from the Bowie, Ariz., deposit have proved their ability to remove water and carbon dioxide from sour gases, and 130 tons were sold between 1970 and 1972 from the Bowie deposit of Union Carbide Corp.

The fourth area of current usage is a good example of the creation of new technology to solve an environmental problem and recover a valuable product at the same time. The NRG Corp. developed and has onstream a zeolite-adsorption process for purifying the methane gas produced by bacterial action on garbage in a sanitary landfill. The first unit is deliv-

[16] Mercer, B. W., and others. Ammonia Removal From Secondary Effluents by Selective Ion Exchange. Water Pollution Control Federation J., V. 42, 1970, pp. R95–R107.

ering pipeline-quality methane to the local gas company from a plant at Palos Verdes, Calif., and is expected to be followed by many more.

The fifth use, as dimension stone, is another area of longtime but unrecognized use. Zeolite tuffs, because of the ease of quarrying and relative light weight of the stone, have been a source of building material for at least 2,000 years. The Mayas of southern Mexico used this material as did the builders of Naples, Italy, and even some early ranchers in the Western United States. An erionite-rich tuff near Rome, Oreg., is still being quarried for a few hundred tons of facing stone each year.

Preliminary research has indicated a great agricultural potential for zeolites in such diverse areas as soil stabilization, slow release encapsulants for pesticides and nutrients, animal feeding, and deodorant for animal wastes.

Other uses abroad that have not yet entered the U.S. market and the potential uses indicated by ongoing research are covered under Technology.

Synthetic Zeolites.—Synthetic zeolites have a large, expanding, diverse market that often changes by new applications generated in the research laboratories of producers. In 1974, the major market areas were using zeolites for their selective adsorption capabilities as dessicants, gas stream cleaners, vapor adsorbers, etc. The chemical and petroleum industries were using 42% of synthetic zeolites produced, natural gas processing 22%, refining 10%, refrigeration and insulating glass 8% each, industrial gas 2%, and others 8%.

Zeolites have some catalytic effect of their own, are a part of the cat cracking catalyst of choice, and make good support material for other catalytically active agents. In 1974, zeolitic catalysts had 92% of the total cracking catalyst market in the United States. This represented 126,600 tons of catalyst (about 10% zeolites) worth $66 million. Metallic catalysts on zeolite supports were an unknown part of the $12.8 million-per-year hydrocracking catalyst market.

Prices.—In 1974 the clinoptilolite used in the Rosemont, Minn., sewage treatment plant cost about $400 per ton. In that year synthetic zeolites were averaging $2,000 per ton, and cat-cracking zeolitic catalysts more than $500 per ton. In 1976 one company offered natural zeolites that had been "activated by heating" and pelletized at around $1,000 per ton in large bulk shipments.

Foreign Trade.—Trade data are lacking. Inquiries from Europe about availability of clinoptilolite and from South Korea about markets for mordenite presage future foreign trade in natural zeolites. However, aside from the very lively trade in laboratory specimens, the only discernable international trade at present seems to be the importation by Japan of mordenite and other South Korean types.

International trade in synthetic zeolites seems to have some limitations. There has been widespread distribution of laboratory amounts of U.S. products as attested by articles in the foreign literature telling of experimentation involving these zeolites. The low-density, high-bulk characteristics of these materials make for transportation difficulties. This industry seems to be exporting technology rather than product and is opening manufacturing plants abroad at an accelerated rate.

The zeolite catalyst international market seems assured. The complicated technology and highly secretive manufacturing methods for producing the cracking catalyst of choice seem to assure that product rather than technology will be exported. The United States will remain the main source of zeolitic catalysts for the oil refiners of the world.

World Review.—One author[17] estimates an annual worldwide production of 300,000 tons per year of natural zeolites from mines in the United States, Japan, Italy, Hungary, Yugoslavia, Bulgaria, Mexico, and Germany. Some of the large uses for these predate their identification as zeolites and will make tabulation of tonnages extremely difficult; these large uses are as pozzolans in cements and concrete, as lightweight aggregates, and as soil conditioners, for which there is evidence of centuries-old use by Japanese farmers.

Resources.—Available resources of zeolitic minerals will not be firmly quantified for many years; exploration is very active and new deposits are being found.

Tonnages cannot even be guessed at with the fragmentary knowledge now available,

[17] Work cited in footnote 13.

but the following countries apparently have deposits of sufficient grade to have economic potential: Argentina, Australia, Bulgaria, Canada, Chile, France, West Germany, Hungary, Italy, Japan, Mexico, New Zealand, the Republic of South Africa, South Korea, Tanzania, the U.S.S.R., the United States, and Yugoslavia.

The nine zeolites that commonly make up the major portion of the zeolitic rocks in sedimentary beds are analcime, chabazite, clinoptilolite, erionite, ferrierite, heulandite, laumontite, mordenite, and phillipsite. The most abundant in sedimentary rocks are analcime and clinoptilolite. Some of these same zeolites occur in pyroclastic rocks in minable amounts. The reference work[18] previously cited states that if grade and depth of overburden restraints are ignored, the total identified, hypothetical, and speculative resources of zeolites in the United States are conservatively estimated at 10 trillion tons. In approximate order of decreasing abundance the common zeolites are clinoptilolite (including heulandite), analcime, mordenite, erionite, phillipsite, chabazite, laumontite, and ferrierite. The United States probably has the world's largest potential resources of high-grade chabazite, erionite, and phillipsite and the only high grade deposits of ferrierite in the world are reported in central Nevada.

Technology.—Zeolites are very likely the first group of abundantly available natural minerals whose exploitation will come after the establishment of a successful industry based on the synthesis of analogs and of 70 or 80 types not found in nature. Creation of new materials has led to much academic interest and to technological advances by such companies as Union Carbide Corp., Mobil Oil Corp., W. R. Grace & Co., Shell Oil Co., and Norton Co. The availability of the pure monotypical synthetics shortened laboratory time because results could be related to fewer variables and not confused by the effects from impurities and varying pore sizes.

No attempt will be made to divide the proven and potential applications of zeolites between the synthetic and natural because there is and probably always will be significant overlap. For example, pressure-swing-absorption processes utilizing synthetic zeolites have been patented, as has at least one process using natural zeolites to effect oxygen enrichment of air. These processes can produce up to 95% oxygen with most of the remainder argon, and are economically advantageous for plant sizes up to 25 tons per day.

Some of the characteristics of zeolites that make them useful are present in other minerals to varying degrees. The presence of several of these characteristics in a single mineral makes zeolites unique and valuable.

The term molecular sieve partially describes what is probably the most valuable characteristic of zeolites. Specifically, their cage structure makes them porous, and the different pore sizes and shapes of the various zeolites can selectively adsorb or reject different molecules. Use of this property made the air separation unit previously mentioned possible. Zeolites are being used as gas dryers and desiccants in many ways and as purifiers of gas streams.

Besides their purely physical adsorption characteristics, zeolites have unique properties not found in conventional adsorbents. They will selectively adsorb molecules with a permanent dipole moment and other interaction effects. They are valuable ion exchange agents and have types of selectivity for discrete cations not available elsewhere. This can be useful, as already proven, in the concentration and removal of radioactive strontium and cesium from the waste waters of nuclear facilities, for removing the ammonia (NH_3^-) ion from waste water treatment plant effluent, and also for altering the physical parameters and catalytic activity of the zeolites. As an example Linde's zeolite 4A is the sodium form of their zeolite A structure, which, when the sodium is exchanged for calcium, has an effective pore size 1 angstrom larger and becomes their zeolite 5A.

Research on zeolites has so far been concentrated on the synthetics. There are valid reasons for this, as previously mentioned, and there are also valid reasons why application and characterization research on the natural zeolites should be hastened. Economics is chief among these because there are many potential applications of great usefulness in the agricultural and environmental areas where the less expensive minerals can be used whereas the more expensive synthetics might never find a market.

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[18] Work cited in footnote 13.

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